THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. LXXVI. No. 1963.] LONDON, DECEMBER 25, 1900. [52ND YEAR. PRICE 6d.

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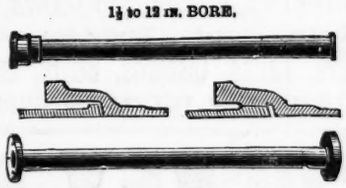

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THE "MELDRUM" FURNACE
At "The SHEFFIELD TELEGRAPH" Offices.

Reprinted from "The SHEFFIELD TELEGRAPH" June 27, 1900.

A SAVING IN FUEL OF £18 PER WEEK.

A couple of months ago when coal, which formerly cost us 8s. per ton rose to 12s. 6d., we read a lecture on the cost of steam production by John Holliday, in which the following paragraph appeared:—

Mr. Bryan Donkin, M.Inst.C.E., has published figures from some tests he carried out with different kinds of fuel in the same boiler, the conditions in all cases being the same; the results are comparable on the basis of the cost of fuel required to evaporate 1000 gallons.

Kind of Fuel.	Cost of Fuel per Ton.	Water Evaporated per Pound of Fuel.	Cost of Fuel per 1000 Gallons Evaporated.
	s. d.	lbs.	s. d.
A. Dust Coke	5 0	6	3 8
B. „ Welsh Coal . . .	10 0	8	5 3
C. Large „	22 0	9	10 11

Discovering that the Sheffield Gas Company made a considerable quantity of coke dust, which they gave away to builders and others, we entered into a contract for a supply for three years. Having a spare boiler, we had Meldrums' forced draught fitted, and soon discovered that coke dust made a very satisfactory fuel for steam raising. Our second boiler was then fitted, and we are now burning coke dust on the two almost exclusively. From an economical point of view, the experiment is very satisfactory, as will be seen from the following figures:—

Average week, Coal only, on One Boiler.

	£ s. d.
45 Tons at 12s. 6d.	28 2 6
Ashes at 2s., Seven Loads	14 0
	£28 16 6

Present Consumption on Two Boilers.

	£ s. d.
Six Tons of Coal at 9s. 3d.	2 15
Coke Dust	3 4 0
Two extra Stokers	2 12 0
Flues cleaning	10 0
Ashes, 12 Loads at 2s.	1 4 0
	£10 5 6

We shall be pleased to show the arrangement to anyone interested in the subject of the economical production of steam. There is no smoke from the chimney stack of the "Telegraph" Office, which is another good point in favour of coke dust as fuel.

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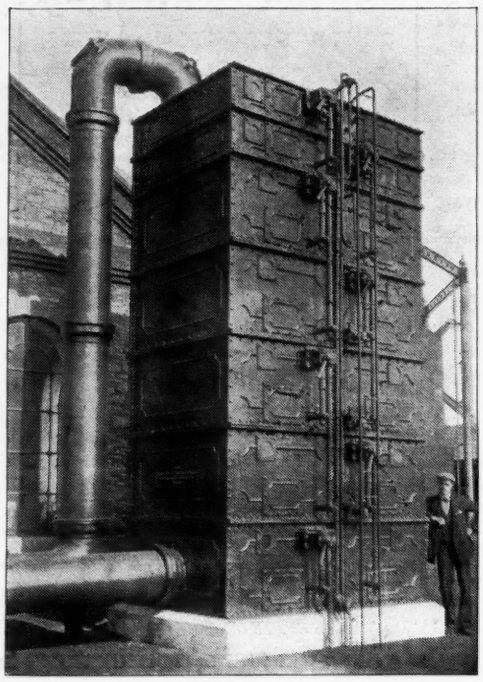

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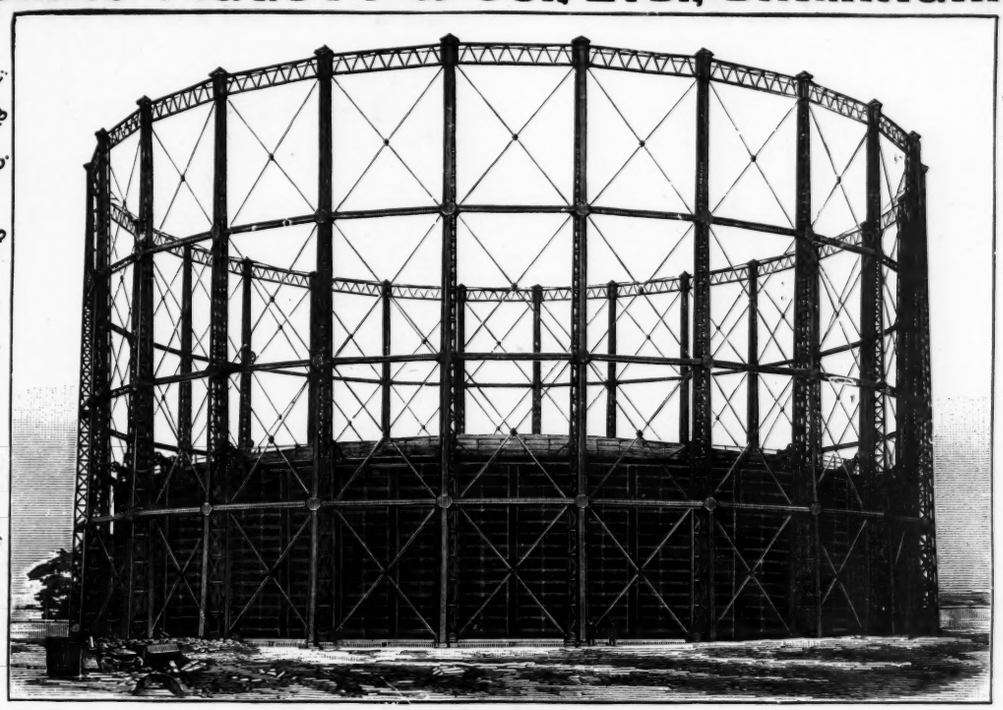

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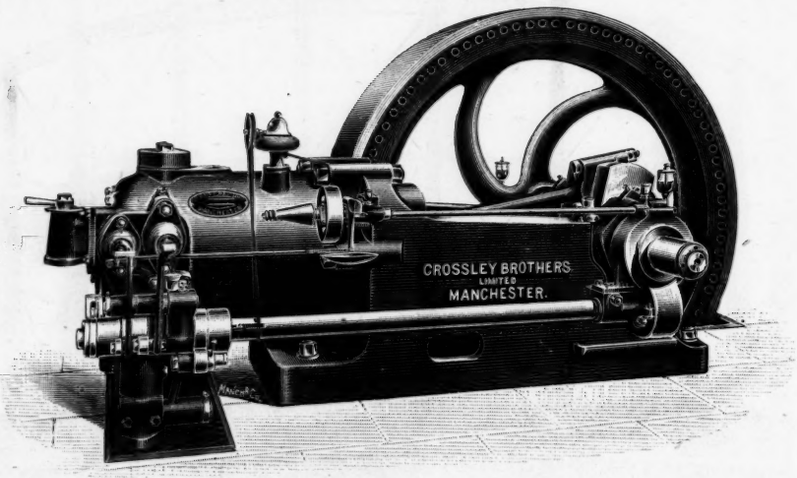

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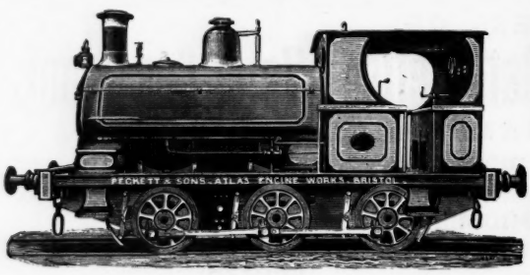

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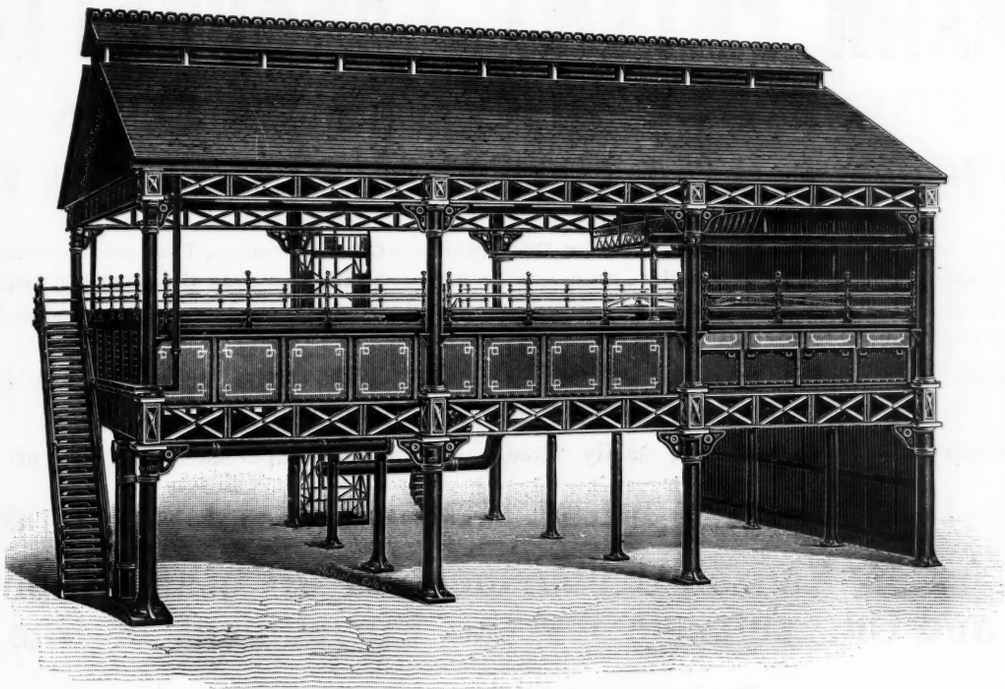

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View of Six Purifiers, Superstructure, Roof, &c., erected by R. Dempster & Sons, Ltd. (*From a Photo.*)

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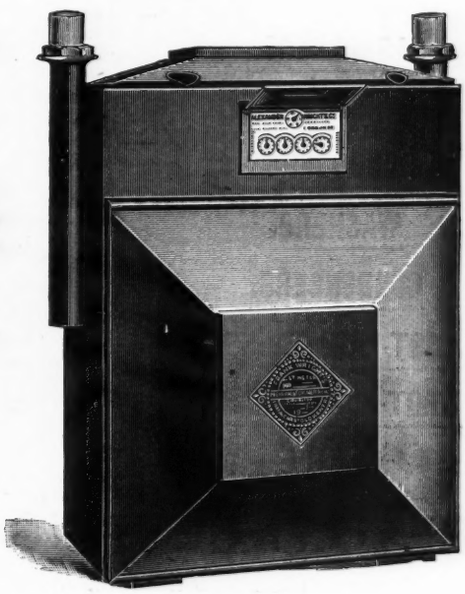

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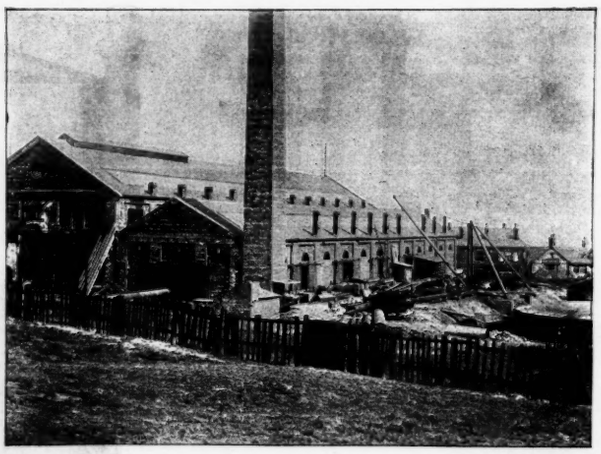

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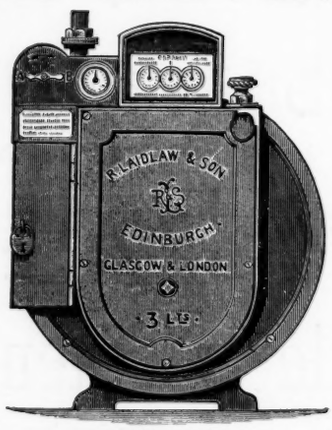

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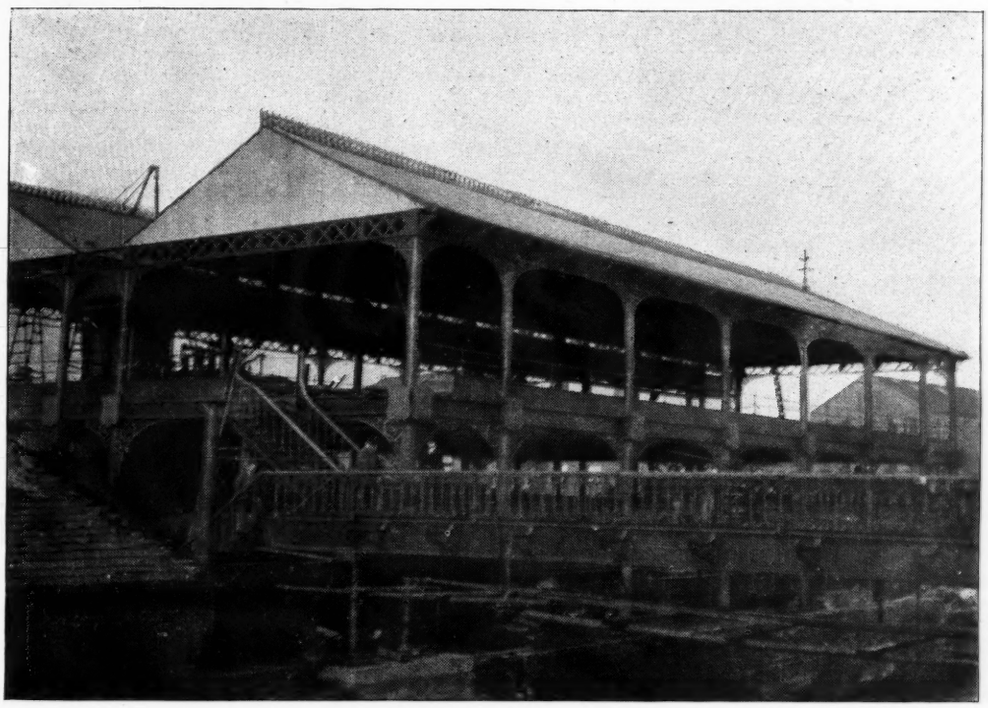

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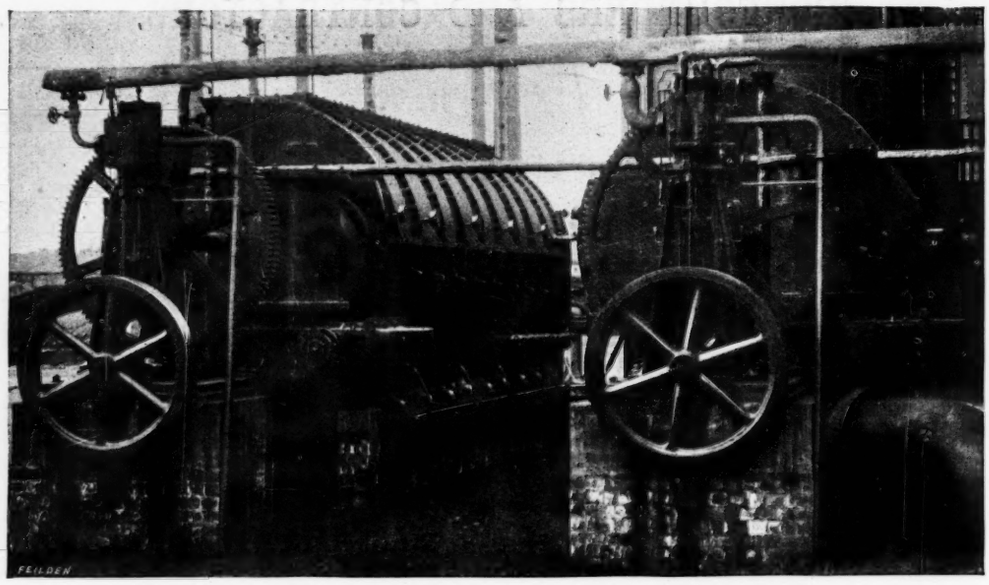

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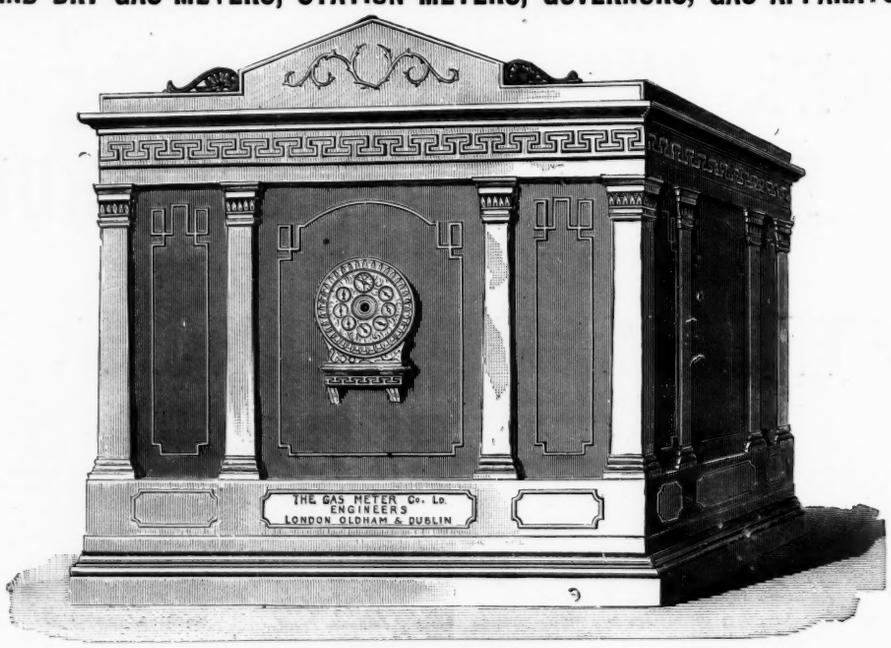

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Belfast	1,700,000	Bordentown, N.J.	125,000	Commercial (2nd)	850,000
Belfast (2nd)	4,500,000	Winchester	225,000	Commercial (3rd)	1,250,000
Brussels-Ville	750,000	Shanghai	225,000	Rotterdam	850,000
Brussels-Ville (2nd)	750,000	Stockport	600,000	Dorking	150,000
Liverpool	3,500,000	Norwich	1,000,000	McKeesport, Pa.	500,000
Liverpool (2nd)	4,500,000	Holyoke, Mass.	600,000	G.L.&C.Co., Bromley	3,750,000
Tottenham	750,000	St. Joseph, Mo.	750,000	G.L.&C.Co., Nine Elms.	2,750,000
Tottenham (2nd)	750,000	Lea Bridge	350,000	Durham	200,000
Santiago de Cuba	400,000	Lea Bridge (2nd)	350,000	New York	4,000,000
Swansea	750,000	Stockton-on-Tees	500,000	Scarborough	800,000
Manchester	3,500,000	Edinburgh	2,000,000	Perth, W.A.	125,000
Brighton	1,750,000	Guildford	350,000	Bremen	550,000
Preston	1,400,000	Brentford	1,200,000	Maidenhead	225,000
New York	1,200,000	Syracuse, N.Y.	850,000	Epsom	225,000
Southport	750,000	Bridlington	150,000	North Middlesex.	150,000
Bath	1,000,000	Middlesbrough	1,250,000	Wandsworth.	1,800,000
Newburg, N.Y.	350,000	Croydon	1,250,000	Aarhus	800,000
Newburg (2nd)	250,000	L. & N.W. Ry., Crewe	700,000	Falmouth	150,000
Hoylake	125,000	Taunton	225,000	Southampton	800,000

SINCE JANUARY 1ST, 1899.

Hartlepool	750,000	Stockport (2nd)	600,000	Faversham	200,000
Utrecht	1,000,000	Croydon (2nd)	625,000	Birmingham (Swan V'ge)	1,500,000
Deventer	150,000	Maidenhead (2nd)	225,000	St. Gallen (Switz.)	225,000
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Bournemouth	1,000,000	G.L.&C.Co., Fulham	1,750,000	Southampton (2nd)	500,000
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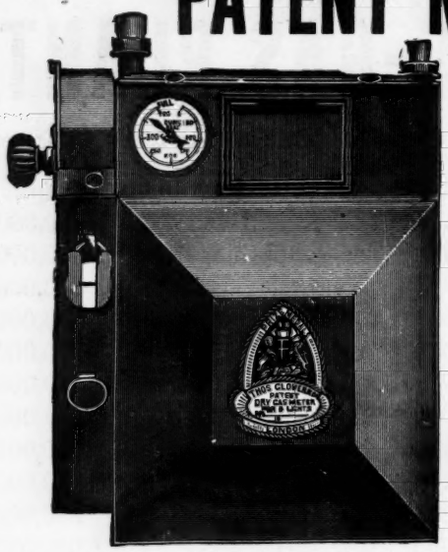

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EDITORIAL NOTES.

1900.

A Retrospect of the Year.

IF the end of an ordinary year is a chronological event which always touches the imaginative and reflective faculties of civilized mankind, and arouses the human mind to a sense of the flight of Time which is only paralleled in individual experience by the recurrence of a man's own birthday, the close of a century naturally deepens this ordinary impression in a degree as exceptional as the event itself. In a sense, of course, every moment that passes is the termination of all phenomenal duration; and centuries are of no more account than moments in the unbroken series of sensations which we call the course of Time. Yet our imagination refuses to regard the passing of a century of our Era as an insignificant circumstance. One feels, vaguely, that it means something more than the succession of one year's date by another; but the sentiment is elusive, and one cannot separate it clearly from the throng of more familiar thoughts which crowd in upon the occasion of those accustomed anniversaries when the peculiarly human faculty of looking before and after finds its fullest scope. We do not, therefore, aim at making our Retrospect of the year 1900 to any great extent an exercise in Centennial reviewing. Some few important landmarks must, of course, be noted; but the general history of the past hundred years of gas manufacture and supply cannot be given here, even in the baldest synopsis. It is enough to remark that when the century which now closes opened before the eyes of the generation then living, not only was there no gas lighting industry, but scarcely one object of political, civil, or industrial origin on the whole planet which the present generation takes as a matter of course was then in existence. The British Empire itself was not in being; and the chief link uniting Englishmen of to-day with their ancestors of that period is the Blood and Spirit of the Race, which, under God's Providence, has made the Old World a New World in all essentials since that painful time. It is not overstating the case for the gas lighting industry to claim that among the most potent of the material aids to the development and fruitful application of the human understanding during the closing century has been that organized artificial illumination which gas was the first manufactured product to render universally available, and the humanizing and educational value of which cannot be expressed in words. The assembly-room, the theatre, the lecture-hall, the school, the learned society, the technical association, the club and institute for the people—all these agencies of civilization, and more that might be catalogued, owe their very existence, for popular purposes, to gaslight. It is no mean service for any industry to have rendered to an Age and a state of Civilization.

And now, at the end of its first century, the gas industry, like its great contemporaries steam transport by land and sea, and electricity, stands firmly upon the up-grade of its prosperity, powers, and prospects. The past year has been a time of trial and stress—what year is not, to a living thing?—but they have been surmounted and withstood; and the New Year breaks fair, with promise of comparatively calm weather. The country, as a whole, has experienced almost unexampled financial prosperity and mercantile expansion. Prices have ruled high; and labour has been well paid and much in demand. The ugly wail of the unemployed has not been heard for a long time in our land. Men have earned good money; and, generally speaking, they have borne their fortune vastly better than was the case in the last "flush times," a quarter of a century ago. It is really marvellous to reflect that this satisfactory condition of the home population has been coincident with the active prosecution in South Africa of the greatest war in which this country has been engaged since the struggle for the suppression of Napoleon Bonaparte. It is only necessary to read the history of the home conditions under which that conflict was carried on, and compare the facts with actualities, to realize that the difference between 1800 and 1900 is in other respects besides time. The British populace of 1800 burnt ricks of corn, in order that the wealthy should not enjoy that of which they were themselves deprived. In 1900 men of the same class tax themselves willingly for the support of the dependants of their fellows

fighting for the Flag across the sea. This is more than a Revolution. It is a Re-birth of the Nation.

The year's financial history of British Gas Companies is so bound up with that of legislative changes, that it is difficult to recount one without bringing in the other. Thus, the fashion of converting and consolidating original and additional share capital upon a basis more nearly approximating to the level of the actual returns on the current value of the investment has been pursued, usually without opposition, because the operation is found to redound to the advantage of the undertaking, and indirectly to the public, without cost to the community. The possibility of employing money to advantage in many ways led to a general cheapening of gas stocks, much to the gratification of the best judges of such matters, who deplored the exaggerated valuation of what is after all but industrial property. When people have bought gas stocks too dearly, the fact is apt to weigh too much in the counsels of the administration, and cause the maintenance of the corresponding rate of dividend to be a consideration overpowering policy of greater prudence. Another cause of depreciation of the market price of gas stocks was the general sacrifice of dividend necessitated by increased prices of gas, in the case of sliding-scale companies accustomed to pay dividends to the full statutory limit. Where it is the practice to keep a margin of the sliding-scale dividend in hand, this influence has not shown itself so strongly. The year was, indeed, rendered memorable by the circumstance that for the first time since the introduction of the sliding-scale of gas prices and dividends, this means of adjustment came largely into operation against both consumers and shareholders. Owing to a rise in the cost of coal averaging 8s. per ton all over the country—an advance unprecedented since the coal famine year 1873—the selling prices of gas had almost everywhere to be raised from 6d. to 9d. per 1000 cubic feet. On the whole, the public took this enforced increase in the cost of one of the necessaries of town life very patiently, for the reason that householders were at the same time compelled to pay at least 10s. per ton more for their coal supplies of all grades. Where popular discontent with the dearness of gas was fanned into overt agitation by local busybodies, the chief complaint to find utterance related to the detail question of whether an alteration in the price of gas can legally be made retrospective. Contrary to the expectation of many, the circumstance of the existence of a sliding-scale, whereby the shareholders suffered in dividend rateably with the increased price of gas, did not act as a solace to the public. Of far greater importance was the knowledge that gas supplied by municipalities throughout the country was also advanced in price. And this was done in many places, be it noted, specially to keep up the deplorable practice of indirectly taxing gas consumers for the benefit of the ratepayers.

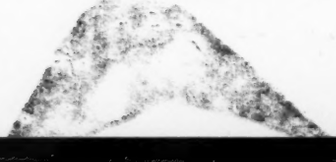
The question of coal was that which chiefly occupied the minds of gas-works administrators during the year. All through the season of Christmas and the New Year—until the lengthening of the days, indeed, brought relief to the gas manufacturing plant—the greatest difficulty was experienced in getting deliveries of coal. The contractors everywhere fell hopelessly behindhand with their consignments. Neither ships nor railway trucks were to be had for money; and some gas-works situated within cartage distance from collieries could hardly get enough coal to keep the holders off the ground. Important gas undertakings in the South of England were reduced to stocks measurable by days—sometimes by hours. Chance cargoes were bought at any price the owners chose to ask; considerable sums of money being necessarily sacrificed in this way. As usual, all manner of theories were put forward to account for this abnormal state of affairs, occurring moreover in a mild winter; but of greater practical moment were the two clear issues that it would become imperative to raise the price of gas as soon as possible, and that penalty clauses of coal contracts are not of the slightest use when they might be of the greatest value.

Gas prices were, as a matter of fact, increased as already stated, at the Lady-day or Midsummer (in Scotland, Whitsuntide) index-takings. The position of most gas companies having annual coal contracts was at the beginning of the year that of depending upon their contractors for the completion, as they were able, of the old contracts which were made at prices greatly below the open market rates. It was inevitable that the fresh contracts to succeed these would not be settled except at a serious advance. The great question was whether this advance, which might be taken as marking the high-water level of coal values, would last. It proved, as we have mentioned, to amount to 8s. per ton for Newcastle coal in the home market. This source of supply was particularly intractable, in consequence of the readiness of foreign buyers of gas coal to strike bargains at top prices, just at the season when the big home contracts should have been sealed. The supply of Midland coal, fortunately, was not so seriously influenced in the same way. After a sudden advance at the pit's mouth of just as much as the Newcastle coal, during the first two months of the year, it as suddenly declined to a price at which it could be purchased to an advantage as compared with the North Country article. Inspired by this circumstance, some large buyers of gas coal held off, and ventured upon the unprecedented course of making a six months' contract only. They trusted to the market weakening towards the end of the year; and this anticipation has been fulfilled.

The coal situation this winter is, so far as British gas-works are concerned, the complete opposite of the state of affairs a year ago. There never was so much coal on the works at this season of the year as there is now. The coal cost a high price, and freights were high; but these conditions have produced the natural effect. Coal and freights have been turned into money as fast as possible; and now, as a general thing, gas companies have more coal than they really know what to do with. Their turn is, therefore, coming. Scarcely anywhere, irrespective of the sliding-scale, has the retail price of gas been advaned to the figure that would be necessary to completely meet the bare increase in the cost of coal, to say nothing of the accompanying advance in other raw materials, gas-works supplies, and labour. Full credit has everywhere been allowed for the improved return from coke, the only residual of gas manufacture that has responded sensibly to the influence of dear coal; and there has generally been something taken out of the undivided balance to square the revenue account. Coke has paid well this year; but tar and sulphate of ammonia appear to be immovable, probably in consequence of the growing supply from sources other than gas-works.

A curious feature of the gas manufacture of the year was exhibited by the carburetted water-gas branch of the industry. The popularity of this accessory of many British gas-works continued unabated on technical grounds; and there are more of these auxiliary plants in use than there were a year ago. Unfortunately, however, for those British gas managers who put their trust in carburetted water gas, of the American kind, the market price of gas oil was advanced in sympathy with the dearness of gas coal. It was published in the last accounts of the Crystal Palace District Gas Company, that, owing to the dearness of coke and oil, the works' costs of the carburetted water gas made by the Company had risen to 1s. 7d. per 1000 cubic feet. The lack of a native supply of suitable oil for gas making is a grave objection to the limitless extension of the manufacture; although fresh foreign sources of this material are continually being exploited, the newest being the distant island of Borneo. A good deal was said in advanced technical circles about the capabilities of Dellwik water gas, carburetted with benzol, as an addition to the resources of a coal-gas works; but the plant was not established on a working scale anywhere in the United Kingdom. Arrangements have been made for the installation of a Dellwik-Fleischer plant at West Bromwich. The position of ordinary coal gas, as the staple product of British gas-works, remains yet as firm as ever. It was, indeed, considerably strengthened during the year by certain parliamentary proceedings to be mentioned later.

Before quitting the subject of gas-works finances and profit and loss, we desire to lay stress on the great success, signalized on several distinct occasions during the year, of the practice of issuing new gas capital in small lots at a fixed price, to suit the small and the local investor. The rights and wrongs of this matter of fresh issues were exhibited at the autumn meeting of the Gas Companies' Protection Association. There it was plainly shown that the best way for a gas company to make friends is to parcel out new stock at a reasonable fixed price among the consumers and the public from whom its income is drawn. On the contrary, the most unpopular gas companies are those whose capital is obtained from the general Money



Market. There is nothing new in this exposure. It is only the moral of the old Consumers' Gas Companies repeated in a modernized shape. Yet it is marvellous how sluggish British Gas Companies are to follow good examples, old or new. Popular stock issues; profit-sharing; adoption of the business methods of ordinary competitive traders—anything and everything of this kind of progress may be exhibited by one company for long years before their next neighbours will do likewise.

Great interest centres in the legislative record of the year. No general statutes of any great importance, as regards the gas industry, became law during the Parliamentary Session of 1900; but the Private Gas Bill business was of the first order of magnitude and far-reaching influence. This was due to the nature of the Bills relating to the Metropolis Gas Supply, and to the dealings of Parliament with these measures. It seemed good to the London County Council to promote a Bill to legalize penalty gas testing by scouts armed with a portable photometer; and to bring under statutory control the efforts of the London Gas Companies to popularize gas by means of prepayment meters and hired fittings. They had far better have left the latter design alone; but the infatuation of a democratic authority for tying up every public enterprise in red tape, proved irresistible, and Parliament yielded to it once more. The portable photometer project was, however, defeated. At the same time, and through the same Committee, the House of Commons had to consider a Money Bill of the Gaslight and Coke Company, and a Bill of the South Metropolitan Gas Company for reducing the initial price of gas under the sliding-scale enacted in 1876, and for lowering the standard illuminating power of the Company's gas. The former Bill was rejected; the latter was passed. Later, in the Upper House, the South Metropolitan Bill was shorn of the provision it had contained for enabling the Company to acquire from the Gaslight and Coke Company the portion of their undertaking lying on the south side of the River Thames. The illuminating-power clauses of the South Metropolitan Act constitute a precedent of vast economical and industrial importance, which is already being followed, and may be widely utilized as time goes on. The Wandsworth and Putney Company, one of the cheap-gas Companies of the London suburban ring, secured a fresh Act on the old basis. In connection with two Acts of the year for converting horse tramways to electric traction, the London Gas Companies obtained a valuable concession of the principle that their mains and pipes should be protected from electrolytic injury. Parliament was engaged upon an interesting inquiry into the merits of Municipal Trading, and took evidence from Mr. George Livesey on municipalized gas supply. It became the rule to disallow powers to manufacture gas-fittings, &c., by Gas Companies, as well as Municipal Gas Committees, in connection with the usual hiring-out clause of Gas Acts.

Gas Companies have not troubled the Superior Courts much in regard to the settlement of disputed cases of gas law. The law of steam road-rolling was further elucidated, by a judgment obtained by the Alliance and Dublin Consumers' Gas Company. The Hull gasholder case finally flickered out, not without leaving a lesson in regard to the law of underground water. An important question arising out of the Building Acts was decided by the Divisional Court against the Wandsworth and Putney Gas Company. Several notable decisions were given by the Appeal Court under the Workmen's Compensation Act. One of the most generally important of these was in *Pearce v. The London and South-Western Railway Company*, which settles the liability of undertakers for their sub-contractors. Much interest was taken in the Kern patent litigation between the Welsbach and the New Sunlight Incandescent burner interests, which ended in a compromise. The expiry in March of the 1886 patent of the Welsbach Company leaves this proprietary with the untried (in the High Court) patent of 1893 as their sole remaining mantle patent.

Gas engineering opinion continued to be exercised throughout the past year respecting the comparative merits of carbonizing coal in inclined retorts and in horizontal retorts with mechanical stoking appliances. All that seems to be decided as yet in this important department of a gas-works is the necessity of efficient coal and coke transporting machinery. This mechanical equipment of retort-houses is independent of the retorting arrangements, which are still unsettled. Gaseous firing has become universal, and large external gas-generators for supplying a battery of settings have come into favour in some big works. Gas washing with oils, by Young and Glover's process, for the removal of naphthalene, has entered upon the commercial stage; and the dry-sealing of gas-purifiers came into wider favour. Carburetting by benzol also became an industrial practice. Outside the works, gas engineers had to consider the expediency of distribution at higher pressures than were customary in old-established practice; and at the works of the South Metropolitan Gas Company, the usual distribution by the force of gravity was supplemented by trunk-main blowers, driven by Westinghouse gas-engine power. A notable improvement in high-power gas lighting for wide streets, open spaces, and works yards was perfected, in the shape of high-pressure incandescent lamps; and a brisk beginning was made in the introduction of these brilliant lamps. In a general way, the incandescent method of gas lighting made enormous progress in public favour. Notwithstanding the saving of gas incidental to this system of illumination, the public demand for gas increased in almost embarrassing volume; rendering it difficult to keep the manufacturing plant abreast of the needs of the time. The use of coal gas for cooking, heating, and driving engines is still growing fast; and some gas undertakings have to make provision for a 20 per cent. increase for the year. Increases of about 10 per cent. are fairly common, which is a happy circumstance for the firms whose business consists in supplying the necessary plant and materials for this swelling trade. Acetylene gas lighting has advanced in some respects, and fallen back in others. The industrial use of large gas-engines received a marked impulse. A fuel gas scheme, using the Mond process, was projected for South Staffordshire.

A memorable incident of the year was the recognition by the most progressive gas engineering opinion of the radical change that has been wrought in the commercial and technical ideals of the industry of coal gas manufacture and supply by the domination of the system of lighting by incandescence. This system, being independent of the normal illuminating power of the gas, as tested by photometry of the luminous flame, supersedes the old standards of quality based on this photometry. The measure of the usefulness of any gas is thus changed from the luminous value of the open flame to the heating power of the gas; its lighting service being performed exactly upon the same principle as its heating and power-generating work. The partial application of this discovery by the South Metropolitan Gas Company, as already chronicled, was resisted by the County Council; but the forces of obscurantism had to suffer defeat. In Germany, gas of 8 to 10 candle power is being distributed by municipal undertakings, to the great relief of the market for the best gas coals. A beginning upon the same lines has now been made in England; but it still remains for the British gas industry to shake off the incubus of the luminous-flame photometric standard, in order to ascertain the cheapest way of working in accordance with the new conditions. Until the incandescent system of gas lighting actually becomes the most generally used, and luminous flames are reduced to an insignificant minority, it will be expedient to continue the production of unenriched coal gas of not less than 14-candle power. But where this obligation no longer holds good, as in the case of Germany, it has been already proposed by Dr. Bunte to distribute a mixture of the commonest coal gas, carbonized in bulk in retort-ovens, with 20 per cent. of uncarburetted water gas. This mixture would have a normal illuminating power of from 4 to 5 candles, and a calorific value of about 550 British thermal units per cubic foot. Irrespective of the merits of any particular prescription for its manufacture, which can only be determined by experience, the "note" of cheap "light" gas predominates in the technical ideals of the time.

There have been some few accidents and casualties to vex and distress the followers of the gas industry; but nothing, happily, of a very terrible character. Indeed, the year was remarkably free from disasters in or in connection with gas-works. A regrettable suffocation case, resulting in the death of two persons, occurred in the Tottenham district, which was chiefly memorable for the proof it supplied that a mixture of gas and air may be fatal to breathe, while not attaining to explosive proportions. A gasholder collapsed in an unexplained manner at Barking.

The political and official side of the cause of Labour suffered several sharp rebuffs in the course of the year, especially at the General Parliamentary Election which

took place in October, and resulted in the discomfiture of the greater number of the professional Labour candidates. Employment generally was plentiful, and wages, especially in the coal and iron industries, ruled high. On the other hand, the building and brick-making trades were in a poor way, which had the effect of easing the market in which the less skilled grades of gas-works labour is chiefly recruited. There were strikes of Thames coal-trimmers in the early spring, and of lightermen in the autumn. The latter is still dragging on. Mischief was made among railway men by the Railway Servants' Union; and a vexatious revolt on the Taff Vale railway system was quelled. This affair gave rise to an interesting point of law which remains unsettled, as to whether a Trade Union can be made answerable for injuries caused by its officials acting in its name. There was another outbreak at the Bethesda slate quarries of Lord Penrhyn, over the familiar question of "recognition" of the Union, which, in this as in other cases, means abject submission to Union domination. The memory of Thomas Shelton, of Leicester, remains to testify to the character of recognized Trade Unionism.

This year having been distinguished by the holding of the latest, and possibly the last, of the French series of International Exhibitions, the opportunity was taken for the convening in Paris, in September, of an International Congress of Gas Engineers, under the presidency of M. Th. Vautier. The congress was well attended, and proved to be an agency for the collection of a valuable set of technical papers. In England, the Incorporated Gas Institute and the Institution of Gas Engineers held successful meetings under the respective Presidents, Mr. E. H. Stevenson and Mr. J. W. Helps. At these meetings, measures were initiated for bringing about a fusion of the two organizations into one truly national and representative Society; but the matter still remains in suspense. The North British and the various District Associations of Managers continued in activity, and justified their existence by their transactions. Besides the doings of the technical societies, gas engineers desirous of being "in the movement" have many calls upon their perceptive and critical powers. The output of technical literature, which nobody who does not desire to be reputed a "fogey" dare neglect, is becoming almost overpowering. To lose touch of it for a week or two, is to be stranded in uncomfortable ignorance of what is going on. Yet however penible is the task of obtaining it, an adequate acquaintance with current technical topics is as his very breath to a professional man. There is only one real Long Vacation in the strenuous career of a modern specialist who aims at mastery of his craft.

Several of our whilom fellow-workers have entered into their rest during the year that is almost past. Mr. J. Blacket Gill, who came of a good gas stock, presided for the last time over the annual meetings of the Commercial Gas Company in October. A highly respected member of the gas profession—Mr. Peter Simpson, of Rugby, who of late years occupied the position of Trustee of the Gas Institute—died in the early Spring. Mr. T. W. R. White, of Sherborne, was a familiar figure at Gas Institute and Southern District meetings. Mr. W. Barratt, late of Grantham, was a founder of the Eastern Counties Association. Mr. J. W. Buckley, of Formby; and Mr. J. Robb, late of Haddington, were representatives of the older order of gas managers. Mr. R. A. Gandon was taken almost before his career had opened. Mr. Richard Clark, of Devonport, was one of the seniors of the profession in the West of England. Mr. William Livesey needs no qualifying description here. Mr. W. S. Randall, taken in the prime of life, was a great loss to the Gaslight and Coke Company.

There have been many changes of professional appointments in consequence of death and retirement. It is the first complete year of Mr. C. C. Carpenter's work as Chief Engineer of the South Metropolitan Gas Company. Mr. G. C. Trewby retired from the position of Chief Constructing Engineer of the Gaslight and Coke Company, and has for the present no successor. Mr. J. F. Bell has gone to Derby in succession to Mr. C. Taylor, retired—Mr. Pooley taking Mr. Bell's position at Stafford. Mr. J. G. Newbigging has the chief engineering charge of the works of the Manchester Corporation Gas Department. Mr. Harold Woodall succeeds to Bournemouth. Mr. T. H. Duxbury was appointed to South Shields, in succession to Mr. W. J. Warner. Mr. S. Stewart retired from Greenock; and his place was taken by Mr. W. Ewing, of Hamilton.

Much more might be written of the events of the year, and still leave a great deal unsaid. The record of the time has been kept, as faithfully as possible, and as completely as circumstances permitted, in the two bulky volumes of the "JOURNAL" for 1900. To this chronicle we must perforce refer for anything that has been omitted in this necessarily imperfect review of the doings of an exceptionally busy year. It is not the object of these Retrospects to be encyclopædic, but only to give in one sweeping glance a presentment of the salient events and the most decided tendencies of the period. As Galileo said of the earth, so it may be repeated of the gas industry of the United Kingdom, "Still it moves!" And that is the great thing. Whether in some respects the organisms within the gas industry, and the personality thereof, move quickly enough, is another question. So far as the work of the "JOURNAL" goes, we can claim that no technician into whose hands the weekly numbers come can fairly complain that he has no indication of the way in which the technical world is moving from time to time. In pointing the way, and recording progress, the "JOURNAL" finds an ever increasing, always a more and more pressing task, because the gas industry itself grows in bulk and in complexity of developments daily.

WATER AND SANITARY AFFAIRS.

The Principal Events of 1900.

THE historian of the year now fast drawing to its close does not find himself able to record the occurrence of any event of such significance, in the field of water supply or sanitation, as to bring 1900 into unusual prominence as a period of exceptional progress. The century, however, of which it is the last fraction, has witnessed great advances in each of the above-named important factors in the health and well-being of the community. To go no farther back than about fifty years, it may be pointed out that water supply has been brought under legislative enactments, that the public health has come under control, and that endeavours have been put forth to prevent the pollution of soil and rivers. The labours of Dr. Parkes caused greater attention to be devoted to sanitary science and hygiene; while those of Hawksley, Bateman, Bazalgette, and Rawlinson resulted in the provision of vastly improved water supply and sewerage systems. With the constitution of the Metropolitan Board of Works in 1855 came the inauguration of a more adequate drainage scheme for the Metropolis. The Board have passed out of existence and given place to the London County Council; the old Board of Health, to the Local Government Board; the Vestries—erstwhile the paradise of Bumble and of his peers—to the Borough Councils. As the result of these changes, we are surely justified in looking for more efficient administration. At all events, we may enter the new century inspired by the hope that the lessons of the past—they have in many cases been hard to learn—will be productive of much good in the future. But before passing into 1901, we may well review what has been done in 1900.

The year opened with the Metropolitan Water Question, which had been more or less before the public during the latter half of the century, still hanging, so to speak, in the balance. The last of the four Royal Commissions appointed to investigate the subject—that presided over by Lord Llandaff—had nine months previously concluded their two years' labours; but their report had not appeared. In the meantime, two of the members of it—Major-General Scott (the Official Water Examiner) and Mr. H. W. Cripps, Q.C.—had been removed by death. The London County Council, without waiting for an expression of the views of the Commission, had given notice of Bills to sanction the purchase of the Water Companies' undertakings and the carrying out of their Welsh supply scheme. That the Council would not be alone before Parliament on the water question was evidenced by the fact that three of the Companies—the Chelsea, East London, and Lambeth—had notified their intention of introducing Bills to enable them to improve their positions financially or structurally, and the eight Companies collectively had intimated their desire that the Local Government Board should be armed with power to require them to submit schemes for additional storage reservoirs in the Thames Valley, and to draw more water from the river and its tributaries. This was the position at the birth of the New Year. The year

was not many days old, however, before we were able to give a forecast of the long-awaited report of the Royal Commission. In the "JOURNAL" for the 16th of January we stated that it was adverse to the Welsh scheme—the existing sources of supply being considered sufficient for the next forty years; and that it favoured purchase and control of the Companies' undertakings by a specially constituted Water Board composed of representatives of the Local Authorities within the existing limits of supply, with a Chairman and Vice-Chairman chosen by the Local Government Board. That these predictions were not far wrong was shown by the appearance of the report on the following Monday. The document was fully dealt with in our columns at the time, and therefore it is unnecessary now to go over the old ground. Suffice it to say that the Water Companies came well out of the inquiry, as they had done in that conducted by Lord Balfour of Burleigh only a few years previously. In fact, the associated Companies, by their Bill already referred to, had anticipated one of the principal recommendations of the report—viz., that further powers should be conferred upon the Local Government Board. The Commission had already specially reported upon the advisability of connecting the Companies' distribution systems; and their suggestions on this matter had received legislative sanction.

The report was well received, on the whole, by the Press; but, of course, the Progressives on the London County Council and their supporters outside objected to it. Consequently, after the lapse of a few weeks, a deputation from the Council, headed by the new Chairman, Mr. W. H. Dickinson, formerly Chairman of the Water Committee, waited upon Mr. Chaplin, at the offices of the Local Government Board, to represent their views on the water question, and to suggest that the Council should be authorized to take over the property of the Water Companies, and subsequently promote a Bill to settle the constitution of the authority to control the supply. In other words, they wished to get possession of the supply, even if they had to give it up afterwards. The idea, as we pointed out at the time, was preposterous. Mr. Dickinson thought that, if the Council had only the Government to deal with, the matter would be settled without any difficulty. But Mr. Chaplin quoted the very emphatic expression of opinion by the Royal Commission, that the Council should not be the public body to whom they advised the water undertakings to be transferred; and he told Mr. Dickinson plainly that the Government could scarcely be expected to support a Bill the object of which was diametrically opposed to that view, while, as far as he personally was concerned, the arguments adduced appeared as in "distinct conflict" with the recommendations of the Commission. This was not very encouraging to Spring Gardens; but worse was to follow. After three weeks of suspense, their hopes were dashed altogether. Their Bills were down for second reading "by order" on the 22nd of March; but, owing to some misunderstanding, the night had been promised to the Irish members. After a disorderly scene, the debate was adjourned for a week; and then the Purchase Bill was thrown out by a majority of 83, and the Welsh Bill withdrawn. Undaunted, however, and apparently impressed with the belief in the value of "pegging away," they have decided to re-introduce their Purchase Bill, accompanied by one to continue the operation of the "sterilization" clause; but, judging from the rebuff they received a few days ago from Mr. Walter Long —Mr. Chaplin's successor, consequent upon Ministerial changes, at the Local Government Board—they cannot expect it to pass, especially in view of the decision of the Government to introduce a Water Bill in the session of 1902. They have very prudently dropped their Welsh scheme. After the Council's Bills were disposed of, the Speaker advised the House that the Bill of the associated Water Companies, which was also down for second reading, could not be entertained as a private measure; and it, too, was withdrawn. With regard to the other Bills, the Chelsea Company did not proceed with theirs; but the East London and Lambeth Companies carried their measures successfully through both Houses. The result has been to give each Company additional storage.

The general water legislation of the past session has been so recently dealt with in detail, that it scarcely calls for mention here, except to make the retrospect of the year complete. A Bill was passed to reconstitute the Lea Conservancy Board, on which the New River and East London Water Companies will have only one representative each, while their contributions to the revenues of the Board will be increased, without apparently any commensurate benefit. But the proposals of the promoters were not allowed to pass without protest from the Companies. A scheme was brought forward for the constitution of a Water Board for South Essex; and it encountered a great deal of opposition. Hertfordshire was alarmed at the possible effect upon the county of the sinking of the proposed wells; Cambridgeshire contemplated the draining of the Cam to the point of exhaustion; the Water Company immediately concerned characterized the scheme as the worst which had ever been presented to Parliament; and the East London Company condemned it as unnecessary, and likely to result in financial failure. In the face of so many formidable objections, the House of Lords declined to sanction the project. Nor were they more considerate to the Bill of the South Essex Water Company for the construction of new works, though it had the able support of Mr. E. K. Burstal and Mr. Baldwin Latham. Better fortune awaited other companies. Incorporation was conferred upon those at Great Berkhamsted, Higham Ferrers, and Woodbridge; and additional powers and extended limits were granted to a number of others. An Act obtained by the Southport Water Company contemplated the transfer of the undertaking to a Joint Water Board, for the formation of which permission will be sought next session by the Local Authorities of Southport, Birkdale, and West Lancashire. A similar Board was sanctioned for Bury and the district, as well as a Water Trust for Airdrie and Coatbridge. Acts to transfer the undertakings at Exmouth, Hemel Hempstead, Menstone, and Spalding were passed; powers were conferred in various cases to acquire lands for the protection of the sources of water; and the Corporation of London obtained authority to construct subways for the accommodation of pipes and wires belonging to parties having the right to lay them in the streets of the City.

Schemes in hand for affording additional supplies of water have made steady progress during the year. The visit of inspection paid to the works towards the end of June by the members of the Staines Reservoirs Joint Committee, left a very favourable impression upon their minds. Operations were not formally started till April, 1898, yet the smaller of the two reservoirs now in course of construction, the combined capacity of which will be 3300 million gallons, was in a very advanced state, while considerable progress had been made with the larger one. In addition to this, a good deal of pipe laying, bridge building, and syphoning had been carried out. The Contractors (Messrs. John Aird and Sons) had nearly 2000 men upon the works; and it was hoped that by next summer the smaller reservoir, estimated to hold 1400 million gallons, would be ready to receive water. Mr. Shaw Lefevre attempted early in the year to create a scare by questioning, in letters to "The Times," the stability of the puddle wall in the embankments of the reservoirs; but he found a formidable opponent in Sir Frederick Bramwell, who demolished his alarmist statements. The Engineers of the scheme (Messrs. Hunter and Middleton) are perfectly satisfied as to the adequacy of their embankments to sustain the pressure of water upon them. An important addition was commenced in October to the great works by which Manchester is supplied with water from Lake Thirlmere. In the presence of a numerous company, the Lord Mayor (Mr. T. Briggs) laid there the first length of a second pipe-line, consisting of 50 miles of tunnels and "cut and cover" work, and 45 miles of pipes, the greater portion of which will be 44 inches in diameter. The cost of the work, which is being executed under the supervision of Mr. G. H. Hill, will be between £400,000 and £500,000. The gigantic scheme which Mr. James Mansergh is carrying out for the supply of Birmingham with water from Wales has been advanced at all points, the weather during the summer having been favourable for the execution of the works. One aqueduct—that from Elan to Dolau—which was in the hands of Messrs. John Aird and Sons, is practically complete; and good progress is being made with the others. At the end of July, the Oldham Corporation witnessed the completion of a scheme for the provision of additional works, for which powers were obtained some years ago, by the formal opening of the Rooden reservoir, the first turf of which was cut on July 30, 1894. It has a capacity of 265 million gallons. Early in the year, some initial steps were taken in the

direction of carrying out the scheme entrusted to the Derwent Valley Water Board by instructions being given for the survey of the sites for the Ronksley and Howden reservoirs. The engineering of this important work has been placed in the hands of Mr. E. Sandeman, who displayed such conspicuous ability in connection with the construction of the Burrator reservoir of the Plymouth Corporation. In September, a commencement was made by the Halifax Corporation with the Walshaw Dean reservoirs, which will add 2½ million gallons of water to the daily supply of the town. Among the smaller works undertaken during the year may be mentioned additional filter-beds and pumping plant by the Bristol Water Company, and the commencement of a new station at Melling by the St. Helens Corporation.

Fortunately there have not been any very serious accidents or unusual meteorological conditions to interfere materially with the supply of water over the country. First to be noticed is the serious leakage—to the extent of about a million gallons a day—from the Thirlmere water-main, which was brought to the notice of the Water Committee of the Manchester Corporation in January. Shortly afterwards, Guildford was visited by heavy floods which inundated the water-works, disorganized the service, and caused great leakage. Fortunately, former connections with the Woking Company's mains allowed of assistance being rendered by that Company, and testified to the utility of intercommunication. Owing to an accident to a main, a portion of the district of the Lambeth Company had to be put on a restricted supply during August; and a breakdown in the pumping plant at St. Ives (Hunts) deprived the town of water. The large main from Vyrnwy to Liverpool has revealed a weak point at Colebrook, a few miles from Northwich, for a serious burst occurred in August, making the third in the course of twelve months. Other accidents, such as are incidental to undertakings of the character of those connected with water supply, do not call for notice.

Though there has not been any case of great magnitude before the Courts this year, several noteworthy legal points have arisen during its progress. First in importance, probably, was the action taken in August by the Corporation of Harwich to compel the Tendring Hundred Water Company to furnish a constant supply of water under pressure in the borough, which it was alleged they had failed to do owing to their selling largely in bulk. The defence was that the inefficient supply complained of was due to defective fittings in the houses; moreover, it was contended that the parties aggrieved should seek a remedy otherwise than by *mandamus*. The Court, however, declined to support the contention, and the writ was issued. Another case in which proceedings against a Water Company were successful arose at Oystermouth, where the occupant of a house on very high ground complained that he could not get a supply. The Company contended that they were not bound to furnish water to the highest house in the neighbourhood, which the one in question certainly was; but they were fined £10, with a continuing penalty of £2 a day. A rather singular case occurred at Brymbo, where a colliery proprietor sought to recover from the Water Company money alleged to have been paid as water-rate under legal duress, with the view of inducing the Company to give him a supply of water, which had been cut off; but he failed to establish his contention. Curiously enough, in some subsequent proceedings, which arose on the Company wishing to compel him to take his water by meter, owing to the great waste going on upon his premises, they failed, and were fined £18. This dispute had been going on since 1893; and it had a melancholy termination, inasmuch as the plaintiff died during a week's adjournment of the final proceedings. This gave rise to the contention by the Company's representative that the action should abate; but the Bench were advised to the contrary. The East London Water Company scored a good point against the London County Council on a special case stated with the view of having a declaration by the Court as to the use of water from hydrants or fire-plugs for other purposes than the extinction of fire. It was decided that the Company had a perfect right to use their own water as they pleased. The Oldham Corporation were made aware that they could not with impunity cause the pollution of water, even though it was only to be used for compensation purposes; and the Stroud Water Company were restrained from taking water from a stream so as to detrimentally affect the working of a mill. The Denbigh Corporation learnt to their cost, as others have done, that the steam-roller must not be used to the injury of mains, whether they convey water or gas; and Mr. Timms Ludgate, an oil merchant of Brighouse, had the fact impressed upon him by the Halifax Justices that when the owners of a water undertaking decline to supply, he must not give instructions to a plumber to tap their mains on his own account. Various wasters of water have been very properly fined during the year. Although not strictly a legal subject, the movement initiated to obtain an alteration in the law in regard to the rating of reservoirs may well be noticed here.

Several interesting questions bearing upon water supply and sanitation have come before the technical societies during the year. The control of water undertakings and the sources of water supply was brought under the notice of the British Association of Water-Works Engineers by Mr. C. E. Jones; but, though the subject was referred to a strong Committee, the only result has been the presentation of the somewhat inconclusive report which appeared in our columns last week. The Association had a good summer meeting at Cardiff, when useful and profitable discussions took place on the subjects of the rating of water undertakings and the detection and prevention of waste; and at their recent meeting in London they spent some time usefully in considering the subject of the protection of underground water. This young Society may well take credit to itself for having accomplished an excellent year's work. The session of the Institution of Civil Engineers opened in November with a very able address by the new President, Mr. James Mansergh, who made some weighty remarks on the Metropolitan Water Question which cannot fail to help forward the ultimate solution of that difficult problem. Mr. Mansergh holds with the transfer of the undertakings to a public body, but on fair arbitration terms; and the settlement of who is to be the body and what are to be the terms will, there is good reason for believing, if we may judge from recent utterances, be one of the early events in the new century. Mr. Reginald E. Middleton did some good service in reading before the Surveyors' Institution the valuable paper given in the "JOURNAL" this week. As a member of Lord Balfour's Commission, he spoke with authority, and made out a good case for utilizing to the utmost the water that lies at our feet before incurring enormous expense in going for it to Wales. At the same Institution, early in the year, Mr. J. Shiress Will, Q.C., dealt in a very able manner with the law of underground water—a subject to which Mr. Mansergh also referred in his Presidential Address. At the Society of Engineers, Dr. G. Sims Woodhead and Mr. W. J. Ware gave the members an account, in a joint paper, of the disinfection of the water-mains at Maidstone after the typhoid epidemic of 1897. Interesting questions on sanitary matters were discussed at the meeting of the British Medical Association at Ipswich, and also at the Health Congresses in Paris and in Aberdeen. At the last-named place, Dr. Percy F. Frankland suggested the creation of an Imperial Board of Health, having at its head a Minister of Cabinet rank, to undertake scientific investigations into such questions as the treatment and disposal of sewage—a matter which had been dealt with by Dr. A. C. Houston, the colleague of Dr. Frank Clowes in the bacterial experiments now being carried out by the London County Council, an interesting account of which was given by the last-named gentleman at the Society of Arts on the 12th inst. While on the subject of sewage treatment, mention must be made of the large scheme carried out at Manchester, under the advice of Dr. Frankland. Before the same Society, quite early in the year, Mr. W. O. E. Meade-King, one of the Inspectors of the Local Government Board, read a suggestive paper on "Parish Water "Supply and Sewerage;" and at the Institution of Mechanical Engineers, about the same time, Mr. W. Schönheyder brought before the members the important subject of the use of water-meters in checking waste. The holding in London of the annual convention of the American Society of Civil Engineers afforded Mr. Rudolph Hering, of New York, an opportunity of laying before his English professional brethren the results of his researches in connection with the filtration of water.

Among the general subjects relating to water supply and sanitation to which attention has been directed during the year is that of divination. A Commission in Paris and the Society for Psychical Research in London have been

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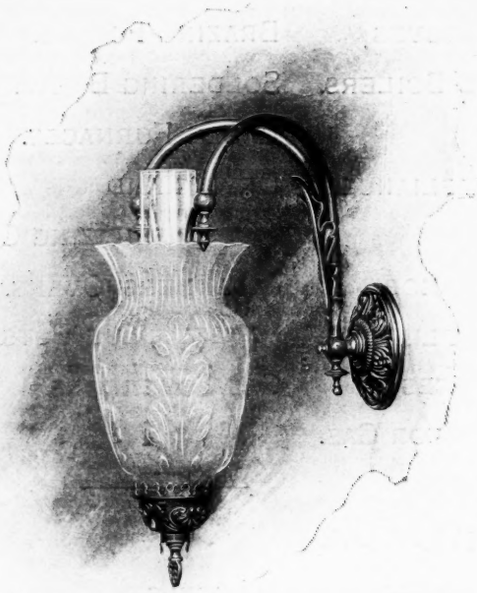

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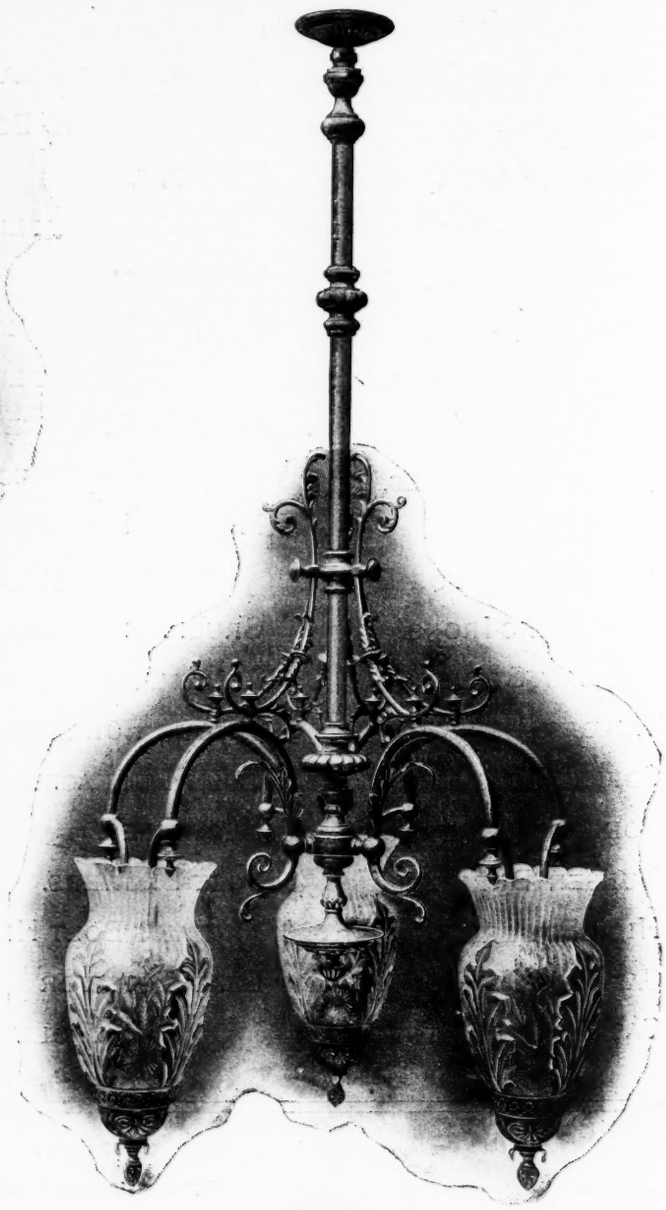

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investigating the matter; and it was deemed of sufficient importance by Mr. Mansergh to be dealt with at some length in his Inaugural Address to the Institution of Civil Engineers. But we do not know that their labours have advanced matters very much, beyond leading to the rather indefinite conclusion that there is "something in it." A good practical test of the "dowser's" power would be to start him on the work of ascertaining the extent of the "lake" which is said to exist under London; and he might also be of assistance in defining the course of underground water when the County Councils and other bodies unite their forces to endeavour to obtain some alteration in the law in regard thereto. An increase in the water-rates at Guiseley led to an outbreak of hostilities between the consumers and the suppliers when the accounts were presented. At Portsmouth, on the other hand, a voluntary reduction by the Water Company of about 15 per cent. in the water-rate, by a change in the basis of charge, averted litigation and promoted good feeling. The proximity of electric cables to water-mains has added one more to the anxieties of conductors of water undertakings, who have had to give serious attention to the effect of electrolysis on their distribution systems. Prevalence of enteric fever at Falmouth, and a somewhat sharp rebuke from a Local Government Board Inspector led to essential improvements being effected in the sewerage and water supply, and subsequently to another abortive attempt being made by the Corporation to acquire the Water Company's undertaking. The insanitary condition of Windsor evoked some strong condemnation of the Corporation and their responsible officials by another of the Board's Inspectors. A noteworthy event of the year was the outbreak of bubonic plague in Glasgow towards the end of August, especially on account of the promptitude with which the disease was grappled with, localized, and eventually stamped out.

The financial position of the London Water Companies has rather improved during the year. However, an entire share in the Adventurers' moiety of the New River Company only fetched £120,000 a few weeks ago, as compared with £122,500 at the last preceding sale.

It will have been gathered from this retrospect of the year that, while it has not been an *annus mirabilis*, it has, at all events, marked progress in several matters of interest in connection with both water supply and sanitation. We therefore enter the new century better equipped, by the experiences of the past, for attacking any obstacles standing in the way of improvement in these two important branches of the public service, on the efficiency of which depend in so large a measure the health and well-being of mankind.

Mr. W. Whyte, of Renton, Dumbartonshire, has been appointed Manager of the Rothesay Corporation Gas-Works, in succession to Mr. J. Ballantyne, transferred to Hamilton. The only other name proposed was that of Mr. G. Keillor, jun., of Peterhead, and Mr. Whyte was elected by a majority of one.

Referring to a notice which appeared in our issue of Dec. 4, we learn that the working of the Gas-Meter Company, Limited, is now in the hands of Mr. F. W. Church, the Secretary, with Mr. Thomas Wilkins as Manager. Both gentlemen have been in the service of the Company for many years.

"Practical Lessons in Metal Turning" is the title of a little work just issued by Messrs. Dawbarn and Ward, Limited, of Farringdon Avenue, E.C. It is a handbook prepared for young engineers and amateur mechanics by Mr. Percival Marshall, who has illustrated the text with 193 original illustrations.

In a recent number of the "Comptes Rendus," the results are given of some further comparative researches by M. Gréhant on the products of combustion from incandescent gas-burners, candles, and petroleum lamps, with special reference to the quantity of carbon monoxide produced. The following are the ratios of the volumes of carbonic oxide and carbonic acid produce: Auer burners, 1 : 655; oil-lamps, 1 : 1025; and candles, 1 : 1610.

We learn from the current number of the "Journal of the Franklin Institute" that, in consideration of the enormous advance in the art of artificial lighting made possible by the invention of the Welsbach mantle, the Institute have awarded the Elliott Cresson Medal to Dr. Carl Auer von Welsbach, "for his discoveries regarding the metallic oxides which may become incandescent when heated, and for the invention of a mantle by the use of which these metallic oxides are commercially available as sources of artificial light." Further that, in view of the many details worked out by the Welsbach Light Company of Gloucester (N.J.), in putting a thoroughly practical mantle on the market, the Institute have awarded them the Edward Longstreth Medal of Merit.

ESSAYS, COMMENTARIES, AND REVIEWS.

GAS AND WATER COMPANIES IN THE STOCK MARKET.

The week before Christmas, generally a rather colourless period in the Stock Exchange, has this year mustered up sufficient animation to produce some changeable phases, and to render it more interesting than is often the case. It began very quietly; and attention scarcely strayed beyond the American and the Foreign Markets. This was followed by decided flatness, owing to the disagreeable news from South Africa, and apprehensions regarding money. Then suddenly the tide turned; and everything became brisk and buoyant until realizations and profit-snatching administered a sharp check, and so the week died out. The condition of the Money Market was again a dominant factor; and the question whether a rise in the Bank of England rate could be avoided on Thursday was anxiously discussed, and some relief was felt when it was found there was to be no change. But it is to be devoutly hoped that this does not merely amount to a postponement of the rise until next Thursday. Business in the Gas Market was very fairly active, all things considered; and the general tendency was decidedly good. Several issues of importance had a material improvement; but the chief of them was an exception to the rule. Good, sound Gas Stocks continue to gain in public favour, and are no doubt well worth buying at present prices. The extraordinary mildness of the season is not conducive to heavy sales of gas, and is bound to check the normal rate of increase. But a change may come at any moment, and, with sharp weather, Companies may be hard put to it to meet the demand for gas. In Gaslight issues, the ordinary was rather weaker, possibly in connection with the extraordinary general meeting; and the quotation had to give way. But the secured issues kept up. South Metropolitan was steady, without any sign of a disposition to advance. Commercials were firm at an advanced figure for the old stock. The Suburban and Provincial group showed out favourably; and Brentford old and new and Brighton ordinary had further advances. The Continental Companies were quiet but firm; and Imperial advanced. There was nothing to note among the remoter undertakings, except a small gain in Buenos Ayres debentures. The Water Companies were more than usually quiet, and with little change.

The daily operations were moderate throughout. On Monday, Imperial rose 1, Brighton ordinary 2½, and Buenos Ayres debenture ½. On Tuesday, Brentford old gained 5, ditto new 2, and Commercial old 2; but Gaslight ordinary fell 1. On Thursday, Brentford new advanced 3 more. In Water on Wednesday, West Middlesex rose 5, and Lambeth 7½ per cents. 1.

BRITISH ELECTRICITY SUPPLY IN 1900—A RETROSPECT.

The year's record of matters and things electrical is a very full one. It does not need the conventional electricians' trick of enumerating and multiplying lamp connections, reduced to the 8-candle unit, to show that there has been during the past year a substantial growth of the electric lighting industry. This is a fact with which the gas industry must reckon, with constantly increasing seriousness, year by year. There are few important centres of population throughout the United Kingdom at the present time in which the whilom speciality of the provision of organized artificial lighting for public and private purposes, once enjoyed by gas, has not been broken into by electricity. Outside the Metropolis, this competition in lighting has usually been entered upon by local authorities, who have, obviously, many advantages in carrying on such a business over those enjoyed by private traders. Rarely as yet have the owners of statutory gas undertakings adequately realized the revolution thus wrought in their *status* and prospects, so as to adjust their commercial methods to the altered circumstances.

Competition has not only been restored in the artificial lighting business generally, by the admission of electricity supply undertakings into gas supply areas; but the principle of competition in electricity supply itself has been confirmed in several prominent instances, according to the intentions of the Electric Lighting Acts. This policy was most conspicuously exhibited by the passing of the first English Acts for the establishment of electricity-in-bulk generating and supply undertakings. Authorities engaged in electricity supply for their own local government areas endeavoured vainly to procure the conversion of their statutory rights in this regard into an absolute monopoly. If this attempt on the part of the municipalities had succeeded, the result would have been that any petty local authority's electric lighting undertaking might have barred the way to the development over the same region of comprehensive electricity supply schemes otherwise capable of serving and linking together the centres of population of the country-side. Parliament, however, limited the privileges of isolated municipalities in this respect, and defined the conditions under which local statutory rights must give way or be adjusted to the greater interest of a larger community.

In the technics of electric lighting, the year does not mark any important advance. No new arc or incandescent lamp came into general use; and accidental extinctions, breakdowns, and fires due to defective wires and connections, were as plentiful as

ever. The rapid extension of the system of distributing lighting currents at the maximum voltage sanctioned by the Board of Trade was attended by a regrettable number of injuries to the person—sometimes fatal. Electric lighting undertakings suffered, with all manufacturing industries, from the dearness of coal and other supplies and materials; and no new mechanical means appeared to reduce the cost of generation or distribution. The most notable technical advance of the year was the growth in favour of polyphase currents. The economical side of electric lighting remains unaltered. Although demonstrably many times dearer than modern gas light, the demand for electric light increases where other considerations besides that of cost serve to recommend it. But the business of supplying it is not yet a paying one in the great majority of cases. The local authorities who thought to cheapen the cost of the lighting current by combining dust destruction with electricity generation, have been disappointed; and few electric lighting undertakings, public or private, outside the largest cities, are yet able to make ends meet, including the necessary allowance for depreciation.

It cannot be said that the supplementary employment of electric lighting currents for heating, cooking, or the generation of motive power for any important purpose has substantially grown. For many years now, electric lighting undertakings have endeavoured to improve the day load on their plant by offering current for the above-named applications at almost nominal charges—usually considerably under works' cost. The amount of business attracted in this way has hitherto been insignificant. It is reported that, in localities where the service can be fairly trusted for regularity, electric lifts are in some demand; but it cannot be truly said as yet that electric power has won its position in British mechanical engineering practice, especially where gas or hydraulic power is an available alternative. Electric house heating and cooking appliances are toys. That no apparatus of the kind has a strong economic reason for existence appears by the witness of the electrical fitting of ships. The rights of this matter can only be distinguished in cases where, as in big ship fitting, electricity gets its due appreciation, and no more for the sake of advertisement. Such an example is that afforded by the Hamburg-American Atlantic liner "Deutschland," the crack ship of the year on the Transatlantic service. The electric plant of the vessel is as big as that of a good-sized town; being capable of supplying some 2550 incandescent lamps. There are besides 70 connections for small ventilators, and 375 connections for curling-irons. The power circuits feed 23 motors, aggregating 50-horse power; and also eight electric stoves with a current consumption of 128 amperes, two water-heaters for 16 amperes, and two egg-boilers for 16 amperes. This is scarcely an extensive list of power and heating applications of electricity under exceptionally favourable conditions.

It seems to be understood that, while electric power transmission and electric driving are making fair headway in British factories—especially, as might be expected, in the newer establishments that a prosperous national trade causes to spring up on every side—in these examples the electricity is specially generated on the spot. The problem that actually awaits solution, by the several electricity-in-bulk generation schemes which were sanctioned by Parliament this year, is whether the product of these new concerns will find a better demand among power users than even the largest electric lighting undertakings, as that of the Manchester Corporation, have been able to create for their power branch. Much has been said about the prospects of the new undertakings, in the matter of distributing power among an industrial population in their homes, and to this extent superseding the factory system; but all this, and a good deal more of the same order of speculation, is "in the air."

The year is chiefly remarkable for the opening of the longest underground electric tramway in England, between the Bank of England, in the centre of the City of London, and Shepherd's Bush, on the extreme west. This line is an improvement on the older City and South London, and City and Waterloo lines, and forms an important link in the new chain of similar lines which is being projected to establish electric transit all round and across the Metropolis. These proposals will require to be systematized in the coming session of Parliament. Meanwhile, an experiment has been successfully completed at Kensington for testing the capabilities of electric traction for working the ordinary passenger trains of the Metropolitan and District Railways; and positive progress seems to have been made in settling the data by which the pending question of the application of electric traction to the complete working of a main line of railway must be determined. The early adaptation of the existing Metropolitan street tramways to electric traction was taken into the range of practical politics; and in Glasgow and other important centres of population electric tramways grew and multiplied.

To all this dazzling electric traction business, there appeared a distinct shadow—the question of the electrolysis of street gas and water mains by wandering currents. This new trouble of gas and water works engineers certainly grew nearer and more defined. Although the standard of efficient and adequate preventive measures in regard to this consequence of working tramways electrically has been set by the Board of Trade in the pioneer example of Bristol, and has been observed elsewhere, a disturbing number of shocks have been felt by men and animals in different localities served by electric tramways. These shocks ought not to occur. Where they do, they are a proof that the electricity concerned is acting *ultra vires*. It may as easily reduce the metal of iron mains as knock down wayfarers. Parliamentary action has been taken in respect of this impending danger by the South Metropolitan Gas Company, whose interests were directly threatened by the electric tramway legislation of the year; and it is scarcely possible to formulate what further defensive measures may yet be found necessary in view of the threatened general extension of such legislation.

In view of the danger of electrolysis, which attaches peculiarly to the single overhead trolley-wire system of electric tramway working—in which the current returns through the tramway metals—it is not reassuring to reflect that no tangible progress was made during the year in the direction of superseding this dangerous system of working by something free from such risk. The surface-contact principle of electric tramway propulsion remains where it was a year ago. The underground conduit system, expensive as it is, seems to be the only means of working an electric tramway innocuously and without creating an eyesore; and even this method still wants a good deal of careful working out. The overhead trolley driving wire, with a second similar wire to convey the return current, is not a favourite with anybody. Independent electric road carriages, and especially the electric cabs put upon the London streets, driven by accumulators, have failed to keep the roads.

No noteworthy addition to the manufacturing processes depending upon electrolytic actions has to be chronicled. Carbide of calcium, for use in acetylene gas lighting, has proved to be one of the most expansive of these new electrolytic manufacturing processes—which is one of the ironies of modern industrial enterprise, seeing that every acetylene flame probably displaces an electric lamp, if it supersedes anything.

THE USES OF TOWN HIGHWAYS AND BYE-WAYS.

For several months past, a considerable portion of the main thoroughfares of the City of London, and more particularly of the streets forming the ancient highway between the Cities of London and Westminster, along the northern bank of the River Thames, passing through the "village" of Charing, has been in the condition shortly and expressively designated as "up." The public using these streets in every sense have been much inconvenienced by this condition of the roadway; and naturally the references to the matter in the London newspapers have been, in Bret Harte's phrase, "frequent and painful and free." The London County Council have taken cognizance of the circumstance; and the newly-born Metropolitan Borough Councils have cried out against the Fate which reserved this trial, and sprung it upon them on the very threshold of their existence. Finally, of course, a Member of Parliament must give himself the trouble of asking the Home Secretary whether the attention of his Department has been drawn to the circumstance of the streets of London being torn up; and, if so, whether he would consider the desirability of putting such operations under the control of the Commissioner of Police. In due official phraseology, the Minister promised not to lose sight of the subject; and there the "incident" closed, so far as any Parliamentary or Government action is in question. The London County Council cannot say anything, being themselves one of the chief offenders against the amenity of the streets in respect of the beginning of their great Strand widening scheme. The time taken to make up the new part of the street does not support the presumption that the unrestricted municipal control of the roadways for all purposes would tend to minimize the amount of public inconvenience caused by operations on the subsoil.

The protests and comments of the general public and of the newspapers in regard to these street engineering works, are like the complaints of angry children when they discover that there is a nasty powder in the blandly-offered spoonful of jam. The newspaper people and the other speakers for the great dumb public incessantly clamour for "jam," in the shape of competitive supplies of electricity, Government telephones, and similar luxuries; and they never fail to be intensely amazed and angry when they learn that the provision of every additional service of the kind involves the tearing up of the streets. Then they appeal to the London County Council to "do something." There follows much talk as to the imperative necessity for the construction of subways for accommodating all the necessary pipes and wires; and the public, soothed by the talking, turn away with the aspiration that these subways might be made "at once." Such was, in sober truth, the comment of a leading London newspaper upon the last subway discussion at the County Council. Just as though a structure of the kind could be had for the asking—made "while you wait," so to speak. To read rubbish of this kind, makes one despair of the intelligence of our lay instructors on the Press. Apart altogether from every other consideration—cost, practicability, and expediency—to construct a subway in any old street would involve such a tearing-up of everything, that the way would be blocked for months. And then the British Public would write to the papers demanding to know what all this pother was about, seeing that every requisite pipe and cable was already comfortably reposing in its allotted place under the pavement.

There is not the smallest good in pointing, as is invariably done, to the success of the subways made in connection with the construction of new streets, as furnishing any reason why

the same works should be undertaken for old thoroughfares which it is practically impossible to remake from end to end. As usual in crying out for subways, the public are on the wrong scent. Not if all the main thoroughfares of London and Westminster, or of many a busy English town, were accommodated with these public service works, would the inconvenience attending their use for over-ground traffic be removed. The streets are not commodious enough, "there's the rub!" Of course, it is bad for traffic when the ubiquitous navvy arrives on the busy scene, and having calmly staked out his claim in the midst of the highway, proceeds to make his occupation effective by barricading himself in and sinking a hole in the expensive paving. But this is no worse than the stopping of a parcels van outside a warehouse, or the breakdown of a cab in the middle of the road. There are always stopping vans, and carriage breakdowns, at every few yards of a busy street; whereas the accidental navvy only occurs at comparatively rare intervals. All the popular vilification is reserved for the navvy; whereas for one such invader of the thoroughfare in a mile, there will perhaps be half-a-dozen new shop frontages in course of construction, every one involving a procession of rubbish or materials carts, and constituting an encroachment on the already too narrow sidewalks in most streets.

In hardly an instance has the work of street widening, which is a municipal responsibility of the first order of magnitude, kept pace with the increase of population and traffic. This is one reason why, when we are asked to extend the scope of municipal activity in all sorts of directions, we object that this means of doing necessary public service has not brought itself credit in discharging the elementary duties of its position in the community. In London, especially, street accommodation has been allowed to fall sadly behind the requirements of the day. As the "Engineer" recently remarked, an increase of population of the capital from under one million to six millions in a century, is a notable fact. Sir John Wolfe Barry, in his address to the Society of Arts last year, said everything that it is necessary to say on this matter. The pity is that all the Lord Mayors of London, and other important people in the local self-government of the Metropolis, including the National Government, should have left it for an independent Engineer to say. The streets and sidewalks are not half wide enough for the traffic they have to accommodate. It is difficult, and frightfully costly, to make the structural alterations necessary to correct this shortcoming, which, as we have already remarked, is not peculiar to London. Far otherwise, indeed; for it is the necessary and natural condition of all the really ancient, notable streets in the world.

The problem thus presented by Old London, Old Paris, Old Vienna, Old Berlin, and even Old Birmingham, is open to attack in different ways which will be suggested by the names of these world-towns. A new thoroughfare altogether can be made by clearing away all the buildings along a chosen line, with the double object of creating an additional business street, and of relieving the undue pressure on the old ones; or the latter can be widened, heroically at a blow, or piecemeal. There is great variety of procedure; but essentially street widening and additions can only be effected in one of these ways. Of them, the second—the stretching of old arteries of traffic to accommodate the fuller stream of life—is at once the most desirable and the most costly and difficult. Pleasure, fashion, and trade have a tendency, too strong to be controlled, for continuing to flow in the historic and accustomed channels. Sir J. Wolfe Barry has acutely pointed out that the enormous modern development of travelling facilities between town and suburb, so far from relieving the congestion of the central region, materially increases it; for at some time or other everybody "comes to town," and always to the ancient centres of street life. Unfortunately, the Metropolitan Local Authorities did not perceive this in time; or, if they did, they sat still and made no attempt to provide for the increased volume of central street traffic circulation which has actually come about their ears.

It is of the essence of a suburb not to be self-contained; if it were, it would be a town of itself, not a suburb. Now, there are large Metropolitan areas which are fairly self-sufficing; and in many localities the main arteries of traffic happen to be of ample dimensions. Consequently, nobody feels the want of subways there. The cry for subways is only raised in regard to thoroughfares which are far too small for the ordinary traffic. This point leads to another, of very great and pressing importance. It is disappointing to find even the "Engineer" a little foggy on the subway question, and falling into the vulgar error of confusing the admitted benefit of subways made with, and for, new streets, with the problematical advantage of tunnelling (say) Fleet Street expressly for this purpose. What we claim is that, instead of charging all the expense of the tearing up of the roads for the laying of pipes and cables against the hypothetical credit of a subway, it would be fairer to charge it to the organic cause of all traffic congestion, accidental and continuous—the insufficiency of the highway itself. After the present disturbance of the Strand-Fleet Street road is at an end, the blocking of the traffic will be almost as bad. It is a mere question of degree. Six stationary hand-barrows in a mile are at least as obstructive as one navvy, where there is no room for either.

We find ourselves in cordial agreement with the "Engineer," however, on the point—which has already been advanced in these columns—that it does not always follow that every new and additional service, whether in the shape of main pipes, cables, or fast tramways, must find accommodation in the principal thoroughfares. Naturally enough, as our contemporary remarks, those who wish to run wires, or anything else, from one point to another go the shortest way, which is usually the ancient line of communication—in other words, along the principal thoroughfares. The point sought to be made in this regard is, that in future any such disturbance of a main thoroughfare should be specially justified. Otherwise, use should be made of a convenient bye-street. It is rather curious that our esteemed contemporary should have been led to join in the general praise of subways, and to propose the bye-street route for trunk mains, by what is happening in Fleet Street, because this ancient highway has no parallels north or south; and to propose making a subway under it is confessedly impossible. Although few ancient thoroughfares are paralleled by equally direct bye-ways, in London or elsewhere, unquestionably this condition often prevails in relation to the more modern town areas which are laid out more or less on the "gridiron" plan. Here, at least, the requirement to use the less busy side streets for through mains and express tramway traffic might reasonably be laid down as being compulsory.

This expedient has been recommended in the "JOURNAL" as a possible device for providing some English towns, including London, with fast-running electric tramcars, without interfering with the main thoroughfares. It has several noteworthy recommendations—assuming, of course, that the prime essential of parallel streets exists. Anyone who will take a tram-ride through one or all of the great South or North London main roads, will perceive that the slow-moving horses have often to be pulled up on account of the still slower-moving general traffic. In order to do justice to itself, an electric tramway needs a clear course; and this it cannot have on the main roads within miles of the Elephant and Castle, or any similar centre. Every timber waggon or coal cart will dispute the right of way with it. There is no such press of miscellaneous, and very heavy, traffic in other places where electric tramway traction answers best. In these conditions, therefore, the fast electric tramway ought to be an addition to the ordinary main-road service, running from one fixed stopping-place to another, through the side streets. There is another consideration favouring the adoption of the same plan—the avoidance of electrolytic injury to the mains in the principal road. Generally speaking, the leading gas and water mains are in the high roads—not invariably, because of late years quieter thoroughfares, less expensively paved, have been made use of for their accommodation, where possible. Still, there are, at any rate, very important mains in all the chief arteries of traffic, and they have been there for many years—since a period when electric tramway working was never dreamt of. It will be a hazardous thing to risk the scattering of electrolytic currents unnecessarily in these old thoroughfares. Who knows how materially the natural dissolution of these old public servants may be hastened by this means? No such risk ought to be run, save under the strongest compulsion of necessity.

We know better than to ask impossible things in this respect. What we do protest is against the heedless assumption that electric surface, or deep-level transit facilities, must necessarily follow the lines of the main thoroughfares where another course is available. It has already been remarked that exact parallels with ancient thoroughfares are not often found. This is because the original makers of these roads naturally took the nearest route, and had no occasion to duplicate the track. They were, however, very prone to make short-cuts, diagonally, "across country," from one central point to another. Sometimes these short-cuts became leading thoroughfares; but very often they remained undeveloped and in bad repute, for various reasons. Their existence, however, can often be traced on a map of any ancient town. London is burrowed through and through with them; and at the present day a man who knows his London well enough, will get from one end of the City to the other, through quiet bye-ways, with a saving of time and of buffetings as compared with the transit by the high-roads. The American "gridiron" plan of city building would never have commended itself to the early town dweller. He would have missed his diagonals sadly. Where these ancient short-cuts exist, it might be possible to restore them to their original time-saving use.

One sees by all these considerations, which are not by any means exhaustive, that the subway cannot be the panacea for all the woes of the wayfarer when the streets he favours are "up." A great deal more might be advanced, on the same side of the question; but enough has perhaps been said for once. Meanwhile, it should hardly be necessary to observe that those who have a statutory right to the use of the subsoil of the streets owe it to the public to exercise these rights in the most considerate and least objectionable manner open to them in their various circumstances, and especially to be quick over it.

The manufacture of sulphate of ammonia from gas liquor was at one time suspected of being the cause of what are called the odours of Paris. As the Paris Gas Company's (La Villette) works are close to the Aubervilliers sewage farm, there was some reason for doubting this. However, investigations made in the neighbourhood of isolated gas-works have entirely dispelled the idea. At the coke-ovens of Lens, for example, the output of which is about 10 metric tons of sulphate day, no odour resembling that of Paris is perceived.

THE WORKMEN'S COMPENSATION ACT AND CASUAL LABOURERS.

In its recent decisions on appeals under the Workmen's Compensation Act (which were referred to in our "Editorial Notes" last week), the House of Lords has once more justified its position as the final Court of Appeal; and the Law Lords have furnished another proof of their capacity to give a common-sense interpretation of the statute law. The judgments in the cases of *Lysons v. Andrew Knowles and Sons, Limited*, and *Stuart v. Nixon and Bruce*, will be welcomed by all who desire to see the Workmen's Compensation Act construed on the lines of its obvious intentions and meaning, rather than in that spirit of super-subtle literalness which seems at times to obscure the intelligence of our lawyers. The comments made in these columns last March on the judgment of the Court of Appeal in the first of the two cases named, showed clearly enough our dissatisfaction therewith. The facts of the case are probably within the recollection of our readers.

The plaintiff was a miner in the employ of the defendants, and was incapacitated from work by accidental injury on the second day he was on duty in their colliery. The County Court Judge awarded him compensation under the Act; but the Court of Appeal held that, the plaintiff not having been in the service of the defendants for two weeks, it was impossible to ascertain the amount of his "average weekly earnings," as provided in the first schedule of the Act. On this ground, therefore, the Court held that no workman could be granted compensation in respect of an injury received during the first two weeks of his employment. They subsequently (and consequently) held, in the case of *Stuart v. Nixon and Bruce*, that the dependants of a workman accidentally killed in the course of his employment, who had only been continuously employed by the defendants for four days prior to the accident, were not entitled to compensation under the Act.

These decisions, as we pointed out at the time, excluded from the benefits of the law of 1897 the very numerous body of casual labourers who, especially at the Docks, are rarely in the service of the same masters for more than a few days together. We also remarked that they would have the effect of denying to the winter hands taken on every year by gas companies the legal right to compensation for accidents occurring within the first fortnight of their engagement. That any companies would avail themselves of such a strict, and, as it then appeared, and has now been held to be, an inaccurate interpretation of the law, we refused to believe; but it is to be regretted that one at least of the leading gas undertakings has adopted the narrower-minded view. There are some people who can never appreciate the wisdom—to put it on the lowest ground—of preferring justice to law, where the legal obligation does not, according to their view, equal the moral.

Fortunately, however, the House of Lords have now decided that, in the cases in point, the legal and the moral obligations coincide. Their judgment is to the effect that the substantive intention and meaning of the Act is "that compensation should be given to every workman in certain places when the injury happened to him in the course of his employment," unless his incapacity for work did not last beyond fourteen days. Lord Halsbury made short work of the point that the compensation is to be in accordance with the provisions of the first schedule of the Act; that the schedule provides for payments based on "average weekly earnings;" and that if the workman were not employed for at least two weeks, his weekly earnings could not be averaged. He took the view that the obvious intention of the Act was to establish a relation between the compensation to be granted and the man's earnings; and that the words "average weekly earnings" were inserted in the schedule solely for the purpose of establishing this relation, and not in the least for the purpose of limiting or cutting down the right to compensation contained in the sections of the Act. He was of opinion that there was in the schedule no repeal of a right which had first been granted; and that, if it were impossible to ascertain a man's "average weekly earnings," arbitration or some other means of determining the amount to be paid might be taken. This is obviously justice; and it will be admitted by everyone to be a more worthy interpretation of the law than that given by the Court of Appeal.

The remarks made by Lords Halsbury and Davey in delivering their judgments have been hailed with delight by those whose political partisanship leads them to decry the merits of the Workmen's Compensation Act. The assertion of the Lord Chancellor that it was impossible not to recognize that the Act presents difficulties of language and construction, and that words have been used which perhaps are not the best chosen for the solution of the problem which lay before the Legislature, is acclaimed by the critics as final proof that the authors of the Act were incompetents. Why, what Act is there upon the Statute-Book dealing with infinitely variable circumstances affecting some millions of people, of which the same might not be said? Are there, for instance, no difficulties of language and construction in the Companies Acts? It is absurd to single out from all the statutes that, in the process of their interpretation, give so much employment to the legal profession, one measure in particular, simply because the statesman chiefly associated with its enactment is one round whose personality party conflict rages with unusual acrimony. The Workmen's Compensation Act, like many others, needs amendment in some details; but this neither proves its failure nor does it counterbalance its far-reaching benefits.

SIR LOWTHIAN BELL AND OTHERS ON FOREIGN COMPETITION—THE DANGERS OF SELF-SATISFACTION.

Experts and journalists—terms, unfortunately, rarely synonymous—still differ widely as to the possibilities and probabilities of American iron and steel goods to any material extent displacing English in our home and foreign markets; as to whether there are any grounds for the charges brought against manufacturers in this country of being behind their rivals in methods of production and distribution; and as to whether England or the States possesses the greater natural advantages. The reviews are full of interesting and mutually contradictory articles. The journals of the engineering profession and of the iron trade take, some the optimistic—all's for the best in the best of all possible business communities—view, others the pessimistic; while still others take the intermediate line that we have probably got something to learn from our fellow competitors, but that we may be depended upon to learn it sooner or later.

Earlier in the year, we commented at some length upon a series of articles that appeared in "The Times," from the pen of a special correspondent who had made a personal inspection of the principal engineering works in the States. That correspondent avowedly laid the most stress upon those points in which he considered that the Yankee manufacturer excelled, or had the advantage of, his English competitor. The articles in which he embodied the results of his observations have been bitterly resented in some quarters, because the correspondent did not catalogue nor emphasize the points in favour of, and creditable to, the manufacturers in this country. The resentment is quite unjustified; for the purpose of the articles was to draw the attention of English manufacturers, not to those particulars in which their methods are beyond question the best, but to the advantages which they might add to those they already possess, and to the nature of the competition they must expect to encounter in the future. In our opinion, a debt of gratitude is due from the engineers of this country to "The Times" for their enterprise in obtaining so excellent a first-hand account of what is being done on the other side of the Atlantic.

Sir Isaac Lowthian Bell, whose long and distinguished connection with the iron trade claims respect for his opinion, has taken up the cudgels on behalf of his English brethren, both in the columns of "The Times" and, more recently, in his address to the Institution of Junior Engineers; but we cannot say he has altogether succeeded in making good his contention that the competition of American manufactures need not really be taken seriously by the producers in this country. Sir Lowthian stated in the address to which we have referred that he had not been in America himself since 1890; and that fact does not strengthen his position in combating the statements of one who has made exhaustive inquiries and investigations there as recently as last year. Events have, moreover, certainly justified the contention of "The Times" correspondent that we should witness a very considerable influx of American iron and steel into this country so soon as production in the States exceeded the demand. That such an influx has commenced is shown by the fact that, while the total imports of unwrought steel into this country in 1899 equalled 77,290 tons—a figure nearly double the previous highest, and twelve times the tonnage imported in 1892—for the first ten months of this year, the quantity of unwrought steel imported from the United States alone equalled 96,011 tons; and by the end of the year it will probably exceed 140,000 tons. These figures are worth a good deal of surmise; and they speak of the English market only. The growth of the imports of American goods into the Australasian Colonies is far more remarkable. We shall not easily displace those goods with others of our own manufacture.

Sir Lowthian Bell's address has served to demonstrate the differing opinions and attitudes of the engineering journals very strikingly; the "Engineer" and "Engineering" both devoting editorial articles to the subject on Friday week—the one expressing satisfaction with the address and with the position of the English manufacturer as complete as the dissatisfaction expressed by the other. The "Engineer" takes the line of argument so favoured by all criticized persons—namely, that of denying what was never alleged. Our contemporary evidently has in mind the articles of "The Times" correspondent when it speaks of "men who have permitted themselves to be carried away and overpowered by American effusiveness of talk, of hospitality, and of size—there is something very telling in a big works, and our friends across the water are quite aware of the fact"—yet it says that "nothing has been too bad" for such men to say of "those whose skill, industry, and enterprise have made Great Britain the wonder and envy of the world. Their machinery is bad; their methods antiquated; their enterprise lacking; their skill a thing of the past." So far, at any rate as "The Times" correspondent is concerned, these remarks are quite unjustified. He distinctly refrained from condemning English engineers root and branch. He merely pointed out where they appeared to be surpassed in ingenuity or methods by their

competitors. Some people appear to resent any criticism or suggestion as something in the nature of an insult.

This attitude is always a very unfortunate one to adopt, and never more so than at the present time; and that Sir Lowthian Bell should preach self-sufficiency to the rising generation of engineers is equally regrettable. As our contemporary "Engineering" says, "it is not wholesome food for junior engineers. It is a national vice—to which we of Great Britain have always been prone—to undervalue our foes. We have suffered bitterly for it in the past, time and again, by sacrifice of blood and treasure in the field of battle; and now it is endangering our commercial supremacy. We comfort ourselves with belated official returns and statistics which record only the past; blind to the gigantic engines of competition abroad that have only of late been called into existence, and which are already casting their long shadows forward on our manufacturing industry. He is on friend to the coming generation of English engineers—the juniors of the profession—who blinds their eyes to these portents of future industrial strife. That the uneducated leaders of working men should, for their own purposes, describe 'foreign competition' as a 'bogey' is to be understood; but for educated masters of industry to do so should be hardly conceivable, though unfortunately we have evidence to the contrary."

Surely this is quite the right line to take. What would have become of the gas industry if, when the competition of electric light first threatened its supremacy, and many cried aloud for gas makers to bestir themselves to see where economies could be introduced, where better methods could be adopted, and where fresh processes could be brought into use, the leaders of the profession had counselled its members (and they had agreed to treat with contempt those suggestions, and to dwell self-complacently upon their past achievements? The present position of the gas industry is due to those who recognized and faced the danger, and has been reached in spite of those who affected for long to ignore it; and the manufacturers of this country will maintain their rank in the commercial world only by obtaining a clear perception of the difficulties of their task, and by manfully tackling them. We have never expressed any doubt as to the ultimate result of the contest; what is needed is that it should be early recognized as inevitable.

Happily, Sir Lowthian Bell's contempt for the competition of other countries is not shared by the leading members of the engineering profession. Mr. W. H. Panton, of the firm of Messrs. Dorman, Long, and Co. (who have the contracts for the enormous amount of structural steelwork required by the Westinghouse Company for their new works), took a very different view of the situation in his presidential address to the Cleveland Institution of Engineers. He remarked—

> Whereas thirty or forty years ago England was the workshop of the world, now we have fallen back in the race; and, unless we mend our ways, we shall be out of it altogether. Both on the Continent and in America they have gone far ahead of us. I have, during the last few years, visited all the important Continental and American works, and I have witnessed this for myself with no little regret. We English are far too easily satisfied. I am inclined to think that if some of the self-satisfied ones saw what is being done abroad, a good deal of their self-esteem would disappear. I am afraid it goes from top to bottom. When the average English manufacturer has made what he thinks a fortune, he buys an estate and becomes a country gentleman. The manager, as soon as he has put 25 per cent. on the output of his works, slaps his sides and thinks he has done very well, and will leave well alone. The workman, when he gets more money than he did before, does not try to do as much as he can, because he is frightened he will "spoil the job." The American ironmaster, on the other hand, puts his millions into new works; and his ambition is to be a greater "prince of industry" than he is. The managers vie with one another in "breaking records," and are very openhanded in helping each other, and laugh at "trade secrets." The workmen do their best to turn out as much as possible. They know that the more they turn out, the more money they will get; and the more prosperous the undertaking with which they are connected, the better it is for themselves. It is a good thing for us that the broad Atlantic Ocean is between us and America, or we should be having a sorry time of it. Even as it is, American steel is coming to all parts of Great Britain.

We have made this long quotation from Mr. Panton's address because there is a good deal therein which gas engineers, managers, and men, might well ponder. "We are too easily satisfied." Over how many works' gates and managers' offices might that not be written! As we said the other day, there are some gas engineers, so called, who are satisfied so long as their works never come to grief; but all too many of those of far higher ability are much too easily satisfied. Who is the most successful gas manager of the present day? A man who is never satisfied. The same answer will be found to apply to the question of who is the most successful man in any profession or walk in life. A ceaseless striving after improvement is absolutely vital to any industry subject to competition. That is the lesson that Sir Lowthian Bell should strive to instil into the minds of junior engineers—his own career is a proof of its truth. Self-satisfaction is only too easily acquired, and needs no apostle.

It remains to be seen whether British manufacturers will be satisfied to lag behind their competitors; we doubt it. But there is a good deal of leeway to make up, and a good deal of labour trouble to face; for our workmen are far from grasping the fact that "the more prosperous the undertaking with which they are connected, the better it is for themselves." It is, however, a good thing for all concerned, both producers as well as consumers, that the competition, not only of America but of Germany, has to be encountered; for it will stimulate enterprise, inventiveness, and business capacity in the future, and will tend to the moderation of prices.

MOTIVE POWER FROM BLAST-FURNACE GASES.

Of the various problems which will present themselves to the mechanical engineer for solution in the early years of the new century, two of the most important will be how to employ to the greatest advantage the sources of power now in his possession, and find others which will be available as auxiliaries. It is acknowledged that at the present time there is much latent force still undeveloped; and its discovery and profitable utilization unquestionably present a promising field for the labours of the investigator. Much has been done in the past, but more remains to be accomplished. Let us take the source of power with which readers of the "Journal" are chiefly interested—viz., coal gas. Five-and-thirty years ago, this fuel was employed in driving about 150 engines of the Lenoir type in Paris. At the close of last year, there were 2989 gas-motors in use in the city and the surrounding communes, furnishing about 12,600-horse power; and by this time the number is doubtless well over 3000. In other cities, the extended use of this convenient form of motive power has been equally, if not even more striking. Gas having established itself as a rival to steam, attention was turned to its more economical production. One of the earliest workers in this direction was Mr. J. Emerson Dowson, who successfully manufactured from anthracite or coke a gas which was found to be a good substitute for the coal gas generally employed. The recognition of the fact that producer gas could be used for driving engines led to consideration being given to the utilization for this purpose of the gases generated on so large a scale by blast-furnaces—their quality being only slightly lower than that of producer gas. The idea was first turned to practical account about six years ago; and the great progress already made justifies the belief, according to no less an authority than Mr. Bryan Donkin, that in these gases we have a "new, cheap, and most valuable power agent." This opinion is enunciated in the opening paragraph of an article in the current number of the "Engineering Magazine," extracts from which will doubtless interest readers, in view of the project for supplying power gas in the Midlands, to which reference has been made in our columns.

Mr. Donkin begins by summarizing as follows the successive steps taken in utilizing what he prefers to call "high-furnace" gases: "Thirty years ago they were considered of no value, and were often burnt off at the mouth of the furnaces. They were next partially used, by retaining a portion to heat the air for the blast and burning a larger proportion under boilers to generate steam for driving the blowing-engines. No attempt was made to burn the gases economically, and a considerable quantity was wasted. In 1894, attempts were made at Wishaw (near Glasgow), at Seraing in Belgium, and at Hörde in Germany, to explode them in an engine cylinder, in the same way as producer gas, instead of under boilers." These several pioneer efforts were attended, he tells us, with complete success. It was found that, when thus utilized, the quantity required was only a fifth of that needed when burnt under the old system.

At the outset, the difficulties to be overcome appeared almost insuperable. First of all, complaint was made that the gases were too poor to be ignited in an engine cylinder; then it was said that they were too variable in composition and pressure, that their temperature was too high, and that they were so dust-laden that they would clog the working parts of an engine. All these objections have been met, removed, and turned to account by modern science and intelligent engineers. The low heating value of these gases is due to the small proportion—26 or 27 per cent.—of combustible gases, chiefly carbonic oxide, the rest being inert nitrogen. The calorific values of these gases range from 102 to 112 British thermal units per cubic foot, as compared with 140 to 150 units in ordinary producer gas, and 500 to 600 units in illuminating gas. Nevertheless, Mr. Donkin tells us that, "singular as it may appear, high-furnace gases give, in the few trials yet published, a higher thermal efficiency than either of the other two kinds; as much as 31 per cent. of the heat given to the engine having been converted at Seraing into work." This satisfactory result is, he says, obtained in two ways: "In the first place, the proportion of air admitted to mix with the gases and form an explosive charge is much reduced. . . . For lighting gas the ratio is about 8 to 1; for power gas, 1·4 to 1; while with high-furnace gases the size of the air and gas valves must be so adjusted that about equal quantities of both are admitted to the cylinder." The low heating value of the gases can be remedied by more highly compressing the charge prior to ignition.

Possibly the most important objection to the use of blast-furnace gases is the amount of dust they contain. Mr. Donkin acknowledges that this is still a difficulty, and it requires to be met in different ways for each furnace treated; for in no two iron-works are the gases exactly the same. According to an estimate of Professor Witz, when they leave the furnace, they contain 125 grammes, or 187·5 grains, per cubic metre (35·3 cubic feet). Of this quantity about 100 grammes are heavy metallic dust, which is deposited automatically in the pipes and passages, and usually returned to the furnaces. Nearly all the remaining 25 grammes are got rid of in the purifiers and scrubbers; and from 2 to 3 grammes per cubic metre remain in the gas when it reaches the engine cylinder, and are blown out with the exhaust. At Seraing, Mr. Donkin collected some of the dust, which he found fine and soft to the touch, like flour—not gritty,

like sand. It is this residuum which has been considered so deleterious, and likely to attack the working parts of the engine. But we are assured by the author that this difficulty can be overcome by the high compression that is exerted and the high speed attained by the motor piston.

In connection with blast-furnace operations, Mr. Donkin clearly shows that there are two sources of power which are at present more or less wasted—viz., the surplus store of gases going to waste in the atmosphere, after the needs of the furnaces have been supplied, and the imperfect utilization of those now burnt under boilers, when power might be generated from them by direct combustion in a gas-engine. The usual standard of working blast-furnaces is about one ton of coke burnt per ton of iron made. From 160,000 to 180,000 cubic feet of furnace gases are produced per ton of iron smelted or per ton of fuel burnt. This quantity may be divided as follows: Waste, 16,000 cubic feet, or 10 per cent.; to heat the air-blast, 44,800 cubic feet, or 28 per cent.; burnt under boilers, 64,000 cubic feet, or 40 per cent.; available surplus, 35,200 cubic feet, or 22 per cent. Assuming that 10,000,000 tons of fuel are burnt annually in blast-furnaces in Great Britain, this gives about 2,000,000-horse power wasted, which might be converted into useful work. From a furnace in regular work, about 10-horse power may be obtained weekly per ton of fuel burnt.

The quantity of gases generated in blast-furnaces is so great that the largest engines are required to utilize them. But most of the important German and Belgian firms now make them up to 1000 or 1500 horse power for working with these gases. Mr. Donkin says England is still much behind in this respect. It was, however, in this country that the first attempts were made to usefully employ blast-furnace gases—Mr. B. H. Thwaite having, in 1894, proposed to utilize them in a gas-engine; and he took out a patent for their treatment. The first engine driven with these gases was a four-cycle "Acme," started in February, 1895, at the Wishaw Iron-Works; its consumption being about 84 cubic feet per indicated horse power per hour. There are only a few other installations in England. Abroad, however, the subject has been more carefully and thoroughly studied, and nowhere more successfully than at the important Cockerill Iron-Works at Seraing. On their labours, Mr. Donkin makes the following remarks:—

> This enterprising firm worked independently of the English makers, and in December, 1895, applied some of the gases from their great furnaces, of which they have six, to drive an 8-horse power "Simplex" engine. The discovery that high-furnace gases could be thus utilized was made almost accidentally, while testing the motor with power gas; and it was the first engine driven with gases generated from coke. It is a four-cycle engine resembling the Otto, but with electric ignition, and made with only a single cylinder. The gas had a heating value (taking the water as condensed), of 110 British thermal units per cubic foot, and the consumption at half load was 187 cubic feet per horse-power-hour. Encouraged by this success, the Society in 1898 started a larger "Simplex" engine, indicating from 150 to 200 horse power, and driving an air compressor, which was tested by Professor Witz in July of the same year. This motor, which has now been running successfully for more than two years, and which I saw at work, has a cylinder of a diameter of 31½ inches, with a 39·3-inch stroke. The speed during the trial was 105 revolutions per minute. The work shown on the brake was 181-horse power; mechanical efficiency, 85 per cent.; thermal efficiency, taking the brake horse power, 20 per cent.; consumption of high-furnace gases, about 116½ cubic feet per brake horse power. The result was considered so satisfactory that engines on a much larger scale were planned, and have now been started and tested. Upon this fine power plant—the largest on which trials have yet been made—experiments were carried out at the Seraing works in the spring of this year (1900). The engine is connected direct to the blowing cylinder. Diameter of the engine cylinder, 4 ft. 3 in.; stroke, 4 ft. 7 in.; diameter of the air cylinder, 5 ft. 7 in.; stroke, 4 ft. 7 in.; length of the connecting-rod joining the two cylinders, 14 ft. 5 in.; diameter, 11·8 inches. The experiments were carried out on two consecutive days. In the first day's trial, the engine was tested with a brake, without the blowing cylinder, and gave 573 brake horse power, with a consumption of 123·7 cubic feet of gas per brake horse-power-hour. Mechanical efficiency, 72 per cent.; thermal efficiency, taking the brake horse power, 20 per cent. On the second day the engine was coupled to the blower, and gave 886 indicated horse power and 725 brake horse power, with a gas consumption of 101 cubic feet per brake horse-power-hour. The thermal efficiency, taking the indicated horse power, was 31·5 per cent.

The Hörde Iron-Works, in Westphalia, were the first in Germany to start a gas-engine driven with blast-furnace gases. In 1895, they began experiments on a 12-horse power Otto engine, in which the consumption was 141 cubic feet of gas per brake horse-power-hour. Then they proceeded to motors of larger size, and selected one of a new type—viz., a two-cycle Oechelhäuser—for their work. This engine seems, the author says, to be especially well adapted for use with blast-furnace gases, with which alone it has hitherto been worked; and several large plants have been ordered. It is, however, on an engine of the ordinary Otto type that one of the best trials yet published has been made—viz., those carried out by Professor Meyer, at Differdingen, in Luxemberg, in 1898. The heating value of the gas was 105 British thermal units per cubic foot; the diameter of the cylinder, 17 inches; the stroke, 27·6 inches; and the average speed, 161 revolutions per minute. The engine indicated 79·5-horse power, with a consumption of 79·4 cubic feet per indicated horse-power-hour. As it was coupled direct to a dynamo, the brake horse power was determined from the electrical instruments and taken at 65·3, and the consumption of gas per electrical horse power per hour, 96·7 cubic feet. The thermal efficiency, taking the indicated horse power, was 30·2 per cent.; taking the electrical horse power, 25 per cent. Mr. Donkin stated that this is one of the most complete trials made with these gases; and the results with so comparatively small an engine are, he considers, very satisfactory. The utilization of blast-furnace gases in gas-engines has been fairly started in Germany and Belgium on what can scarcely fail, he thinks, to be a prosperous course. He has seen many plants running, and is of opinion that there is a great future for this work, especially for gas-engines of large power.

PERSONAL.

The New Secretary of the Birmingham Corporation Gas Department.

The successor of Mr. Edwin Smith in the important office of Secretary to the Birmingham Corporation Gas Department was appointed by the Gas Committee last Wednesday; the candidate who secured their preference being Mr. G. Hampton Barber, of Birmingham, to whom we express our congratulations and best wishes for success in his new sphere of labour. The Committee have had a difficult, delicate, and unenviable task in fixing their choice. There was the responsibility of the office on the one hand, and, on the other, so many of the gentlemen who applied possessed qualifications which demanded respectful and grave consideration. Altogether there were 120 applicants, and from these a Special Sub-Committee made a selection of nine gentlemen; and these were further reduced to three—Mr. Andresen, of the Imperial Continental Gas Association; Mr. Hampton Barber; and Mr. George Clarry, of Cardiff. These gentlemen were interviewed last Wednesday by the Committee, who unanimously resolved to appoint Mr. Barber. The office carries a present salary of £1000 per annum.

Mr. Barber, who is 41 years of age, is well known in Birmingham. In his application for the position, he set forth the fact that as a young man he spent four years in the shops of an engineer, and there acquired some knowledge of mechanical construction. But when nineteen years of age—in 1878—he forsook engineering and entered the Treasurer's office of the Liverpool United Gaslight Company. He remained in the service of the Company for nearly twelve years, and during this time passed through the departments having to do with mains, service-pipes, stores, orders for supplies, gas-rentals, public lighting, residuals, and accountancy. He thus gained an extensive knowledge of the Company's business with 60,000 consumers. For the Accountant's Department he was specially selected by the Treasurer; and he prepared the accounts in accordance with the requirements of the Board of Trade, and also the statistics for the Treasurer's guidance in the control of the finances, involving a capital of nearly two millions sterling. As book-keeper he scrutinized and dissected all accounts, and supervised the work of the clerical staff of over one hundred. His position also gave him knowledge of the coal, coke, and chemical markets, and experience in dealing with consumers of gas and coke and other residuals, specifically ammoniacal liquor on sliding-scale contracts. Having achieved this position at thirty-one years of age, and believing that his future advancement with the Company would be slow, there being only one position which he regarded as superior to his own in the Treasurer's Department, he decided to engage in insurance work, and he was ultimately selected by the Mutual Life Assurance Company of New York to organize and superintend their agencies in the Provinces. In his new occupation he made a study of insurance; and three years ago he established in Birmingham the Midland Employers Mutual Assurance Association, Limited, which is a special local combination called into existence owing to the passing of the Workmen's Compensation Act and the high rates for insurance which were at first demanded by the ordinary offices. Since then, a fire insurance scheme, also on the mutual system, has been carried to success; Mr. Barber managing both businesses. His testimonials included letters from the Directors of these concerns, and from Colonel Robinson, the Treasurer, and Mr. William King, the Engineer, of the Liverpool United Gas Company. The recommendations of the latter gentlemen doubtless had great influence with the Committee.

After more than thirty years' successful management of the Kirkburton Gas-Works, Mr. David Stott Shaw has felt compelled to send in his resignation; and Mr. W. Brearley, who has been in the service of the Elland-cum-Greetland Gas Company for about nine years, has been selected out of a large number of applicants, as his successor.

Mr. J. M'Cubbin, Engineer and Manager of the Chorley Corporation Gas-Works, has been appointed Resident Engineer to the Hong Kong and China Gas Company; and he will leave England to take up his new duties about the middle of February. Applications for the position were invited in the "Journal" for the 13th ult. Mr. M'Cubbin went to Chorley in 1896, in succession to Mr. R. Fearnley, who had resigned. Prior to that he was Assistant-Manager at the Greenock Gas-Works.

In connection with the Paris Exhibition, M. Eugene Lebon, a Past-President of the Société Technique du Gaz en France, President of the Organizing Committee for the collective gas exhibit at the Exhibition, and Managing-Director of the Compagnie Centrale du Gaz, has been promoted to the grade of officer of the Legion of Honour; and M. Joaquim-Armand Bengel, manufacturer of gas and electrical appliances, the President of the Jury in Class 75 (gas-fittings and other lighting apparatus), to the grade of Chevalier.

NOTES.

The Proper Fuel Rating for Gas-Engines.

Writing in the current number of "Cassier's Magazine," Mr. A. D. Adams points out that, in generalizing upon the subject of the relative claims of steam and gas engines for industrial purposes, the champions of each type of motor are sometimes content to centre the issue upon the question of their thermodynamic efficiency alone. It is, in fact, the only common ground upon which they can meet, for the prices of fuel, upon which the commercial efficiency depends, are inseparable from purely local conditions. He goes on to show that, in making comparisons of this kind, we must take a unit weight of coal or fuel, and ascertain how much of its thermal energy is actually delivered in the form of mechanical energy at the shaft of the motor, as measured by a brake applied at that point. By so doing, we embrace all possible losses occurring during the transformation from one form of energy to another. However interesting it may be to be able to assign certain fractions of the total loss to special parts of the transforming apparatus, it is quite irrelevant to our purpose; for when the commercial economy of the plant, as a whole, is under consideration, we are concerned only with the total loss of energy in the system. The gas-engine is generally placed at a disadvantage unless the foregoing considerations are regarded. It is quite customary to state the performance of a steam plant in so many pounds of coal per horse power per hour. One often hears of gas-engine power being expressed in cubic feet of gas, which would be valuable if the calorific value of the gas were always known. It would be equally indefinite to express the work of a steam-engine in so many horse power for a given number of cubic feet of steam, without stating the pressure in pounds per square inch and the percentage of moisture in the steam. Even if the work of both forms of motor were expressed in so many horse power per pound of coal, it would not necessarily mean that they were placed upon the same basis for comparison. Some kinds of coal are better for making steam than others, and there is also a difference in the amount and quality of the gas to be obtained from coal of different kinds and price.

The Position of Ventilation Outlets.

Writing to the "Engineer" on the subject of the ventilation of occupied rooms and public halls, Mr. Wheeler remarks that all men in this business find out sooner or later that it is the movement of the air in the room or building that is the chief thing to study; while the means to produce and sustain the air movement have to be chosen and arranged to suit the user. He broadly divides all ventilation into two classes—warming combined with ventilation in winter, and ventilation for cooling in summer. The first class must have an apparatus for warming the fresh air; but no special cooling plant is required for summer use, as an induced briskness of movement is sufficient to produce the desired effect. In both classes, the position of the air-outlet affects the result far and away more than that of the inlet. For winter use, the outlet should be near the floor, in an ordinary room; while for summer ventilation, it should be above the people's heads, but not necessarily at the ceiling-level. It should not be more than 5 feet above them, because it is the air at breathing-level that must be removed and renewed. That far overhead does not matter. The reason for the alteration of the position of the outlet lies in the temperature of the outside walls. In summer these walls are warm, often hot; and they warm by contact the already warm air in the room, causing it to ascend. If it cannot escape by some outlet aloft, it will travel along the ceiling until it finds some wall not so hot as the others, by which it is cooled enough to descend; and a continuous circulation of the air inside a room is thus set up and kept going. In winter, the conditions are exactly reversed. The cold outer walls now chill the air inside, and there is a down current at the walls and the windows. Consequently, the outlet must be at the skirting, so that it draws off the chilled air. An upper outlet requires in winter 30 per cent. more fuel to keep the interior warm; while the distribution of the air is not equal to that with the low outlet. In public buildings, floor-outlets are not convenient, and a horizontal current over the people's heads from inlet to outlet will be found to give the best results.

Governing the Speed of Gas-Engines.

It is pretty generally acknowledged that the requirements to which a motor must conform at the present time are more exacting than they were formerly, both in regard to economy of fuel and regulation of speed. The introduction of the dynamo, and the rapidly increasing demand for motors adapted to the driving of alternators in parallel, have been met by a high degree of excellence in the governing attachments on gas-engines. This is recognized by Mr. Robert S. Ball, jun., in an article on the above subject in the current number of "Cassier's Magazine." He points out that difficulties of a very serious nature had to be overcome to give the gas-engine good speed regulation. The force of the explosion occurring once during every two or more revolutions of the crank in single-cylinder engines was smoothed by extra heavy fly-wheels. The governing mechanism has not been changed to any extent from the well-known centrifugal principle used in governing steam-engines; but the methods by which the centrifugal action of the governor balls or weights operates to alter the speed of the engine somewhat different from the cut-off or throttling mechanism used with steam-valves. One method consists of allowing the engine to miss an explosion by the simple expedient of cutting off the supply of explosive mixture. This is attended with all the disadvantages of coarse governing; for small fluctuations in speed exercise through the governor a somewhat violent change in the amount of energy imparted to the motor. Another system which has found practical acceptance is to alter the quality of the mixture by the regulation of the air and gas valves. It is difficult by such a method to ensure that the impulse given to the engine by the varying quality of the explosive mixture shall be of the desired intensity. A heavy fly-wheel will allay, to some extent, the results of gauging the mixture inaccurately; but extra weight thus added is a poor expedient to adopt for the purpose of covering up the defects of regulating the admission. It is less a matter of uncertainty to vary the amount of mixed gases entering the cylinder than to tamper with the quality of the mixture through the movement of the governor. In engines worked on this principle, the valve under control of the governor varies the supply of gases in the same manner as the throttle-valve of a steam-engine regulates the supply of steam. The result is a varied compression or density at the time of ignition, and a proportionate impulse after explosion. These methods explain in a general way the up-to-date practice of gas-engine regulation; and the results obtained answer the exacting specifications of electrical engineers and others to whom close regulation is an essential requirement.

COMMUNICATED ARTICLE.

THE FUTURE OF THE GAS PROFESSION.

By One of the Past.

(*Concluded from p.* 1509.)

Another question that crops up at intervals is one which, in the interests of the gas industry, should be well thrashed out, and that is the position as regards outside or opposing interests. Is it right or desirable that a director or committeeman should be a substantial shareholder or hold a responsible appointment in connection with firms whose tenders come before him for consideration? Or for the principal salaried officials to be interested in a similar manner, or by way of royalties on patents? But few directors or officials could claim to be absolutely free from some connection of this sort; and if we look further afield, we find that it is the general business practice to make one thing help another. If a clean sweep was to be made of our gas-works board-rooms and offices in respect to everyone who could not say that he held no shares in a trading company doing business with gas-works undertakings, or had no interest in any patent exploited by such companies, the residue that remained would not be sufficient, either in quality or quantity, to effectively carry on operations. And with the continual increase of joint-stock enterprise, the conversion of individual businesses into companies, and the amalgamation of large firms, the inducements to remain immaculate do not increase. Scarcely a week elapses without every director or principal officer receiving prospectuses, allotment forms, &c., offering him the opportunity of securing debentures or shares in some joint-stock concern for the supply of ironwork, stoves, meters, fittings, burners, and so on. In this connection, I have often been surprised that the coal trade—who, according to their account, get their living by losing heavily for nine years out of ten—do not exhibit a disposition to share their losses by a similar process. But the prospectus of a colliery company is as rare as a dead donkey. Another peculiarity is that this kind of document is frequently delivered by the postman on the Sabbath day; and I am told this is not always a matter of accident, but that the senders believe themselves, by this means, more likely to receive careful consideration, which would seem to show that Sabbath-breaking is not confined to Sunday leaguers or cyclists, and points to the need of an association which would agree to destroy unread on Monday morning any prospectus or circular that came to hand on the previous day.

I should be sorry to say a word against those who advocate strict honour and probity in business methods, and have great sympathy with their intentions. But most reformers manage to get the character for being unpractical; and in this case they are apt to forget that it is impossible to make men honest by Act of Parliament, and that if every interested director or officer was displaced to-morrow, there is no guarantee that their successors would show an improvement in the matter of clean-handedness or honesty. The handing over of the management of a gas company to a committee of bakers and shoemakers, would not of itself be a guarantee for strict plain dealing in the future. It would be more a question of personal character than of business connection. It is just the man who makes an efficient gas director that is likely to be in demand in regard to other undertakings; and the engineer who exhibits tact in the construction of one gas-works, is sure to be consulted about others. More than this, the director will increase his experience by his connection with other similar undertakings, and in many ways become the more

valuable. An engineer, too, who goes to advise another concern, will return with freshened and broadened views which will greatly assist him in the matter of future extensions at home; and he will have gathered useful ideas for the improvement of his own present practice. The industry would lose more than it would gain by the introduction of any stringent measures in this connection. There are instances of dishonest practices and of feathering one's own nest to be quoted, and possibly of influencing contracts in a reprehensible manner; and there always will be, while human nature remains what it is. But for every case of this sort, there are two or three on the other side. For example, a member of a firm of gas engineers and contractors has a steady, well-established business, and but little temptation —to say nothing of inclination—to enter upon underhand practices. He is requested, as a favour, to accept a seat on the board of a gas company, and in this capacity repeatedly acts as consulting engineer, and saves the cost of fees. His co-directors look upon his wide professional experience as of great value in regard to all matters that come before them. When a question of extensions arises, the board think themselves quite justified in putting a little in the way of their colleague. They say, with some reason, that he, being always on the spot to answer for the quality of the work, will do as well for them as anyone else would. All this is very unparliamentary, and certainly *might* lead to awful abuses. But it is ordinary business practice, and in nine cases out of ten is really the best course in the interest of the concern. The engineer-director accepts the work in the spirit in which it is offered, and carries it out in a fair, straightforward way; seeing that his firm do not lose, but also avoiding unnecessary expense to the company, and saving them money by substituting second-hand apparatus for new where this can be done with advantage, as in the case of rough castings. Or the engineer of a large undertaking may be asked to accept the appointment of consulting engineer to a small one in the neighbourhood. The engineer-director *might*, of course, plunder the company, and the engineer-manager *might* consider the interests of his outside practice to the detriment of his permanent one; but the cases where this occur are the exception, and not the rule.

The days of slavery and serfdom are past; and every individual is entitled to a reasonable amount of leisure and to freedom in the use of it. He is also entitled to absolute freedom as regards investment of his property. Any attempt to encroach upon these rights without offering a fair equivalent, is of the nature of tyranny, and will not tend to the development of the industry at large, or to the real prosperity of the particular concern. It may be smart practice, when there are a hundred candidates or so for a vacancy, not only to cut down the salary, but to put in stringent clauses about not engaging in other work, not leaving the district without permission, or not having shares in trading companies. But the "lucky" man who secures the appointment will not feel inclined to respect his employers, to take a great interest in the concern, or to put more power into his work than is absolutely dragged out of him. Nor are such limitations likely to recommend the gas industry to the attention of the superior orders in intellect and ability.

Any examination with a view of giving a certificate of fitness for the management of a gas undertaking is but a one-sided affair, if it does not take into consideration the physical condition of the candidate. The man of science may go into his laboratory and deal as he likes with his bottles and glasses, retorts and crucibles; but the manager of a gas undertaking must be prepared to consider the peculiarities of his directors, his employees, and his customers. In the present rush for education, there is a tendency to forget that, although a young man may emerge triumphantly so far as book knowledge is concerned from a course of (say) ten years' study at fifteen hours a day, he may also be a physical wreck—muscles soft and flabby, nervous system hyper-sensitive, with appetite and digestion poor. How can we expect a pallid, slope-shouldered, knock-kneed sort of man to deal with a strike among the stokers, the collapse of a holder, the failure of a principal main, or with less important matters that turn up every day? No amount of success at an examination will give him muscle, nerves, or digestive powers; and he wants a good allowance of all three in order to successfully control the numerous departments of a gas undertaking. One reason why an intelligent workman, in spite of educational disadvantages, may, and does, rise to the control of a gas-works, is his sound physical health. He can stand about for hours at a time, watching the progress of operations; and, if need be, take a hand with the tools himself. His old experiences as a workman stand him in good stead, on the same principle as that a retired criminal makes the best detective. But the great point is that his physical condition is not disturbed by worries and casualties that would send his intellectual superior home to bed, temporarily incapacitated by nervous headache or such like ailment.

So far I have touched upon the weak places in the gas industry, and some of the causes which have hindered its advancement. We boast sometimes of the increase in the consumption of gas; but really—looking at the degree of refinement arrived at by the manufacturers of gas fires and cookers, at the great economy of gas for lighting that is rendered possible by the introduction of the incandescent burner, and the innumerable applications for technical purposes—we should be examining into the reasons why it is not greater. Gas is by far the cheapest agent for lighting and cooking; and also for warming when its convenience and saving of labour is considered. But its use is not so general as these advantages would lead one to expect. In every town there are not only single houses, but whole rows, into which the service-pipe has not yet penetrated. It is a standing disgrace to the industry that the first organization of a body of canvassers should have been left to a manufacturer. Whoever heard of a gas company in England undertaking a house-to-house canvass—a proceeding which American gas managers, who do not neglect this department as usual in England, have pronounced to be indispensable? Under a more energetic and enlightened directorate and adequate staff, the sales of gas might be at least 50 per cent. more than they really are.

We are drawing close up to the end of a century—a season which renders us inclined to review the past, and make resolutions for the future. We look back with regret over the lost opportunities of the years gone by, and forward with hope as to the possibilities afforded by those that are coming. And in this connection, I can readily imagine a time when the duties of the directorate should be defined and limited to such matters as the capabilities of an influential experienced man of business, having a good general (but no special technical) knowledge, can efficiently deal with; and when the whole of the operations, commercial, technical, and general, shall be under the control of an experienced manager, with the aid of efficient clerical and technical assistance in the various departments. There should be general responsible supervision over the whole, in preference to dividing up the operations between two or three heads. In regard to establishments of the first magnitude especially, there has always seemed to me to be too great a *hiatus* between the manager at about £2000 a year and his assistant at £200; and between the secretary at £1000 and the chief clerk at £150. There is room for a good class of second-grade officials, receiving perhaps one-half of the salaries considered sufficient for the chief, and possessing in their own departments a certain amount of responsibilty, but subject to head control. According to theory, there is wisdom in the multitude of councillors; but in practice the real work is done by the few. Out of a board of six or seven, one or two really guide the decisions; and the rest simply say "Ditto to Mr. Blank." Nor is there any particular objection to this, provided the right kind of men get the upper hand. For successful working, there is nothing like a vigorous personality. There is also need for a larger staff—one able, not merely to keep the thing moving, but to develop all possible resources, either commercial or technical, and to keep well up with all that is being done elsewhere. There is room for more investigation in respect to materials purchased and the results obtained from them, to say nothing of pure research. The same as regards the sales department, in respect to new appliances that are continually being put forward.

So much for the particular. As regards the general state of the gas industry, I could imagine our "Institute" supported by all branches of the gas industry, but in which the income from gas undertakings would be at least five times that of the members' subscriptions; having not only an adequate income, but a strong position, and able to deal, not only with technical, but also with commercial matters; and having good educational facilities, in addition to an Examining Board whose certificates would be generally recognized, and of graded orders of merit, so as to avoid the glaring inconsistency of stamping a young man of 21 years of age as a full-blown experienced gas manager. There would be a good reference library, with accommodation for reading abstractors; and it would be a usual thing to send a junior from the provincial gas-works to get particular information. There would also be committee-rooms, where the various orders of certificate holders could meet and discuss matters peculiar to their own particular branch, and the members would be encouraged to attend by their employers, and have their expenses paid. A suite of laboratories, testing-rooms, and workshops, and even an experimental gas-works at some place within easy reach would be available; and, if required, tests, examinations, and reports would be undertaken at fixed fees. Are these practical suggestions, or Utopian dreams?

A Gas-Stove Does not Make a Kitchen.—A Police Court summons was recently made the means of ascertaining whether the introduction of a gas cooking-stove into a conservatory building constituted it a structural addition to a dwelling-house, within the meaning of the London Building Act. The case occurred in the South Metropolitan district. It appeared that a householder employed a builder to make a conservatory at the back of the house, across the casement window of the kitchen. After this was finished, the occupier put in it a gas-stove and a slop-sink, with other articles of portable kitchen furniture. Practically, the place was used as, and for the ordinary purposes of, a back-kitchen; and there was even evidence that it was built with this object. The District Surveyor saw the building in this condition; and he claimed that it was substantially a kitchen addition to the premises, and as such ought to come under the provisions of the Building Act. Against this, the Police Magistrate elicited the fact from the District Surveyor himself that if the gas-stove and other things in the place were cleared away, it would be a conservatory. Practically, therefore, the case amounted to a complaint by the Surveyor of the purpose for which the conservatory was used, which was not held to be sufficient ground for the issue of an order on the summons,

TECHNICAL RECORD.

PROTECTION OF UNDERGROUND WATER SUPPLIES.

The paper which occupied the concluding portion of the sitting at the recent winter meeting of the British Association of Water-Works Engineers was by Mr. W. MATTHEWS, M.Inst.C.E., of Southampton. It was as follows:—

The protection of public water supplies is a matter of such vital importance that, although so much has already been written upon the subject, I feel it should be persistently pushed to the front until legislation having this object in view is generally recognized as being quite as necessary as the Acts providing for the sanitary inspection of dwelling-houses, the notification of infectious diseases, the erection of isolation hospitals, the cleansing of verminous persons, and the inspection of foods and drugs. For all these purposes the general law is sufficient; but to protect a water supply from possible pollution, the costly process of obtaining a Special Act must, in each case, be faced.

The law relating to pollution has been fairly clearly defined by the judgment delivered on the case *Ballard v. Tomlinson*, and is, in general terms, to the effect that no one has a right to deal with the water flowing to, under, and past him in such a manner that it reaches his neighbour in a worse condition than it otherwise would did he not intervene to alter its character; and, further, a person can only be held to be dealing with such water if it can be shown that he either must have known for a certainty, or that there existed strong presumptive evidence, without the necessity of resorting to highly scientific methods of reasoning or to making excavations, that the water is passing from under his land to that of his neighbour (*Ewart v. Belfast Poor Law Guardians*, 1881). By sinking a well or cesspool deep enough to reach the subsoil water, he clearly deals with such water, because its inflow to him demonstrates the fact that the soil is permeable; and there is good ground for inferring that any objectionable matter introduced into the well or cesspool will flow away through the soil, and be carried into the general water system which he has tapped. If, however, a cesspool be sunk of insufficient depth to reach the water, the owner may claim that he is not dealing with the subsoil water at all, and that in the absence of any knowledge of its depth beneath the surface, or of the direction of its flow, he cannot be held responsible for the effect produced by the use of the cesspool. Again, where several houses are adjacent, and each has its own cesspool, sunk to water-level in perhaps only some cases, who can prove which particular cesspit is causing pollution? One or the other may be imperfectly bricked and cemented, and be leaking into the subsoil in such a manner that detection would be impossible, except a detailed examination be made of each pit. Such examination, I need hardly point out, no water company or even local authority, obtaining water outside its own area of jurisdiction, has any power to make, or to insist upon being made by the local sanitary authority. In such a case, the pollution cannot even be traced to the individual, after which it must further be proved that he was dealing with the water in the sense previously explained.

So far as I am aware, there is no law to prevent the deposition of manure or nightsoil upon cultivated land unless it be there placed in such a manner and quantity that, owing to heavy rainfall, it gets washed into the ditches so as to form a veritable stream of sewage; nor is it possible to prevent the deposition of fœcal matter in ditches and such-like places by farm labourers, tramps, gipsies, and others. The pollution of the Maidstone supply was attributable to such a cause; and although the water was in that case fouled after it had left the soil, the same result would probably have arisen had the polluting matter been washed down some crack or fissure in the soil, and so been led into communication with the subsoil water before it reached a spring or well. At Horsforth, the water supply was shown to have been polluted by nightsoil which had been deposited on land in the vicinity of the source of supply.

The inmates of the Hants County Asylum were, some years ago, subject to serious and recurring outbreaks of typhoid or enteric fever, the cause of which was clearly traced to the water supply. The well, sunk with a watertight lining through the upper gravel, took its supply from the chalk beneath; but it was found that, owing to the existence of fissures, there was direct communication between the well and the gravel some distance away, and that pollution which took place there, owing to the presence of sewage disposal works and a burial ground, was conveyed to the well. A new supply was found at another site; and I have not since heard of any such epidemics as were previously so frequent at this establishment. The outbreak of fever at New Herrington (Durham) was proved to be due to the pollution of a well by sewage matter brought through fissures from a farm ¾ mile away.

The most instructive case which can be cited is that which gave rise to an epidemic of typhoid at Lausen, in Switzerland. The water, having become polluted in one valley, flowed underground for over a mile, and was then taken, where it issued as a spring, for drinking purposes in Lausen. Fine flour mixed with the water at the upper station did not reappear at the lower station, whence it was very reasonably assumed that the water percolated through the rocks or very fine fissures rather than flowed in anything like open fissures or well-defined channels. When, however, salt was mixed with the water at the upper station, the spring at the lower station soon yielded saline water. This is most important when we consider what has happened at Eastbourne and other places adjacent to the sea, because we shall be forced to the conclusion that strata which permit of the passage of saline matter are exceedingly likely to permit of the passage of the germs of typhoid and other infectious diseases, as was the case at Lausen.

Other epidemics of similar character have taken place at Bangor, Swansea, Paisley, Chester-le-Street, Caterham, Worthing, and King's Lynn, which were in each case traced to pollution of the water supply before it reached the wells or reservoirs. With but one exception, so far as I can find out, there was no previous warning of danger in any of the above-quoted cases, the exception being at King's Lynn, where the ratepayers themselves had overridden alike the repeated representations of expert advisers and the consequent proposals of the Corporation to seek a purer source of supply. Needless to say, the epidemic was followed by repentance.

As a striking contrast to such a culpable and almost criminal exhibition of ignorance and disregard of warning, it is refreshing to note that the Portsmouth Water Company, not waiting for any outbreak, but acting simply upon the advice of experts who suggested the bare possibility of danger from pollution, have, at great cost, taken steps to safeguard their sources of supply in a manner which deserves the highest recognition. I am glad to know that at least two municipalities are depositing Bills in the ensuing session of Parliament, having as their object the acquisition of land around their sources of underground supply as a means of protection from possible pollution.

In the course of a somewhat extended study of the chalk districts of Hampshire, I have come across a number of places where the deposition of polluting matter might be attended with serious results as affecting the supplies of water drawn from the vicinity, and will venture to set three of them before you as typical cases. In the first case, a swallow-hole in the chalk receives and engulfs the washings from a large track of cultivated land as well as the probable overflow from a number of cesspools, and the scouring of over a mile of public highway and side ditches, the flood being at times so great that considerable protection works have had to be carried out to prevent the roads from being washed away. The water, after entering the swallow-hole, goes to augment the main body of water in the chalk, which, after an underground passage of over half-a-mile farther, partially emerges in a set of springs which, after such floods, become very turbid. Obviously the chalk water is, at such times and up to this point, distinctly polluted, and who can say how far it must yet travel through the chalk before it becomes free from such pollution. The effect of heavy and continuous pumping from a well in the neighbourhood will tend to increase the speed at which this water will travel, and render the time necessary for purification by natural agencies too short, and then the impurities will appear in that well.

In the next case, a group of cottages are situated upon a detached patch of clay, overlying, and surrounded, by the chalk, at the edge of a steep slope, which ends in a rather deep dell close by a pumping-station where water is raised from wells and headings. The cottages have shallow, and in some cases open, cesspools, which, owing to the clayey character of the soil and their general environments, obviously overflow in times of heavy rainfall. There is but one direction in which such overflow can go, and that is down the slope in the direction of the chalk dell, which does not retain water, and is just of that character which is so often associated with swallow-holes of more or less pronounced type; and therefore a ready means of communication with the underground water system is in this case so extremely probable that I consider the existence of these cesspits a menace to the purity of the supply.

The last case is that of some wells and headings made entirely in the chalk, most of them at a depth of 60 to 80 feet below the surface, and cutting numerous fissures at nearly right angles. Some of these fissures have been proved to be in communication with the surface, so that thick chalky water will traverse them, and appear in the headings still in a thick, turbid state. It is obvious that polluting matter might easily, in this case, be transferred from the surface, or from cesspits in the neighbourhood, directly to the water which is derived from this source; and it furnishes a typical example of a case where an area of protection around the works should be acquired, and any possible sources of pollution removed.

It is to be assumed that no proposed site for a pumping-station would have received the sanction of either Parliament or the Local Government Board had it not, when proposed, been considered a good site, and free from probable pollution; but building and other operations have in many cases so altered the surroundings, that sites once perfectly safe are now no longer so. It seems to me only reasonable that a general enactment should be passed to empower any company or water authority to purchase, with the consent of the Local Government Board, and for this sole and express purpose, such land around their sources of supply as may be shown to be desirable for protecting the water from pollution. In the case of Croydon, the Local Government Board appeared to be so impressed with the danger which it was alleged would arise from pollution from agricultural lands that they refused to sanction the proposal to make a

well at Waddon in the bare chalk; and this, together with other cases of refusal, may be taken as indicating fairly well the attitude of that Board in connection with protection.

I do not think that compulsory measures should yet be asked for, but rather that the way to voluntary efforts to protect supplies should be made easier and cheaper than can possibly be the case while each one has to be made the subject of a Special Act. If, later on, the pressure of public opinion, and opposition before Parliament, fails to induce many water undertakings to give adequate protection to their sources of supply, I would suggest that the Local Government Board should, upon proper requisition and after due inquiry, be given the power to insist upon the necessary protection being furnished.

It has been suggested to me that adequate protection would be afforded by the creation, around sources of supply, of special drainage districts to be formed under the powers of the Public Health Act, 1875; but I have, after careful consideration, come to the conclusion that, in at least the majority of instances, this course would not meet the needs of the case. In my opinion, any works having for their object the protection from pollution of water supply must be constructed, controlled, and managed for all time by the body who are relying upon such works as their safeguard. This power cannot be exercised by them under the special drainage provisions of the Public Health Act; and they must go to Parliament to acquire them until the law is amended and general powers are given.

I trust that I have made out a sufficiently strong case to convince you that the acquisition of areas of protection around many underground sources of water supply is a necessity, and that Parliament ought to give greater facilities for the accomplishment of this object.

Discussion.

The PRESIDENT (Mr. C. H. Priestley, of Cardiff) emphasized the remarks of the author as to the inadvisability of works being constructed in an area over which the water authority had no control. Personally, he had had nothing to do with underground supplies; but the same thing as had been described by Mr. Matthews sometimes arose in watershed areas—viz., pollution subsequent to the Act being obtained. In his own town many years ago, water was not taken from the present source, but from another some four or five miles outside the town, and then he believed it was quite pure. Subsequently building operations had gone on largely; and it was not now considered that the water was so good as it was when the Act for the district was obtained.

Professor HENRY ROBINSON (London) sent a communication on the paper, in which he said that he thoroughly sympathized with all endeavours to bring about the protection of water supplies, and prevent pollution. At the same time, it was not unlikely that opponents of proposed legislation in this direction would suggest that private interest had already suffered by water authorities abstracting underground water to the detriment of surface owners.

Professor HULL commented on the importance of protecting underground water. The pot-holes and the fissures so prevalent in the chalk were very dangerous in the matter of water supply; and the same thing occurred in the new red sandstone, with which his experience was more expressly connected. He gave particulars of contaminations some years ago at Liverpool and Nottingham in the new red sandstone area. He was of opinion that the large towns were now beginning to look after themselves very well in this respect. What was wanted was the appointment of persons whose duty it should be to go round from farm to farm in country districts, and poke their noses into every possible source of contamination; particularly over porous material, such as chalk or the new red sandstone. He considered the proper system of disposing of sewage in country districts was to put it on the land; and he ventured to say that where there was a sufficient thickness of soil (from 12 inches upwards), and where there was vegetation of various kinds—either pasturage or arable—the deposition of the sewage on the land as manure would not injure the underground supply. He had great faith in Nature's mode of purification.

Mr. W. A. RICHARDSON (Birkenhead) observed that one of the evils of underground pollution was that frequently a long time elapsed before it was found out, and what generally led to its detection was the outbreak of disease. He considered there was at the present time great necessity for the protection of underground water.

Mr. JOHN SHAW (Boston) remarked that he was glad to say he had little to do with underground waters at the present time; but some 35 years ago up to 20 years ago, he took a great deal of interest in measuring various wells, particularly in chalk districts; and the tremendous distance that he found water would travel, and the various ways it would come into the wells, was very astonishing to him then. He gave a number of examples from his experience at that time in and around Croydon; some wells in the same district showing, by the rapidity with which the water-level was raised after rainfall, that they had a more direct connection with the surface than others. He thought the instances quoted showed that no general rule could be laid down as to the amount of protection that was required by underground water; and he looked forward with some hope to such gentlemen as Mr. Whitaker, Dr. Thresh, and the Council of the Association assisting the members in recording the water-levels in their districts, so as to allow them to come to some conclusion in the matter. Regarding the underground stream flow (which most people recognized there was from the higher part of the chalk to the lower), there were considerable variations. He believed that he was concerned in the first application of lithia to trace this underground flow some 23 years ago. Water was drawn from wells in the lower part of a valley, in order to try to trace the flow from the higher part of the chalk to the lower; and some very curious results were found. Some wells directly in the road did not show a trace of lithia at all; others miles away showed it after two or three days; while others in the road between the upper and lower wells did not show the same results for nearly six weeks. Of course, this result greatly depended upon the fissures in the chalk and some other considerations. But whether water could be polluted from the surface or not, there could be no question that the greatest care should be taken of underground water. It was all very well to say there could be no pollution from this or that source; but if there was a dangerous source or any suspicious place within a mile of a pumping station, the place ought to be watched and closed, if possible, by Act of Parliament.

Mr. WHITAKER, F.R.S., F.G.S., was glad the author had given the Portsmouth Water Company the credit due to them. It was a big Company, and even a big Company could and should protect themselves. The Company were not to blame for any of the evils which had occurred around them. It was the neighbouring authorities who were to blame; and they could not be forced to do anything. He (Mr. Whitaker) had been all over the town of Havant; and a more delightful state of things for fouling a water supply could not exist. The Company a great many years before had offered to take upon themselves half the expense of a sewage scheme; but the people would not take the other half. He believed, however, the Company had now fully protected themselves against pollution; but it was a cruel thing a company should be put in such a position—that a company upon whom a large town depended for its water supply should be troubled by the gross negligence of a small town of 5000 population close at their doors. The Company had acquired springs and land, and had pulled down all the cottages they could to make things safe; and they deserved credit. He hoped that what Mr. Shaw had said with reference to recording water-levels would be taken to heart. There was no more valuable information in districts where the supply was obtained from wells than the constant recording of water-levels a long way round the works. Mr. Matthews did it at Southampton; it was done at Croydon; and it ought to be done everywhere. It was true that no general rule could be laid down in regard to protection; each case must be investigated and dealt with individually. If it was not, the unexpected would surely happen.

Mr. G. GREENSLADE (South Hants Water Company), being interested in underground supplies, had followed the paper with considerable interest. He only wished that some of the members of the Southampton Corporation had been present to have heard the paper and the discussion; and he was sure they would not then have hesitated in giving Mr. Matthews several acres of land round about his works, instead of allowing houses to be built just alongside the headings. The Corporation did not see the value of protecting their area as advocated by Mr. Matthews; and so they had let the matter go on. In his own case, they hoped to have before long the neighbourhood of their works thoroughly protected.

Mr. J. LEES (Tonbridge) remarked that, in the next session of Parliament, some 40 or 50 water schemes (either Bills or Provisional Orders) would come under consideration; and much of what the author had suggested might be very profitably dealt with in connection with them. His (Mr. Lees') Directors last year very wisely, in order to prevent pollution, secured some 53 acres of land immediately adjoining the works; and they felt sure, now that the matter was completed and the land paid for, they had done the right thing.

Mr. MATTHEWS, in reply, said what he was anxious for was that all water companies and local authorities should have facilities given them for safeguarding their supply without having to go to an enormous and totally unnecessary expense. Mr. Shaw had shown them how difficult it was to discriminate between what was and what was not safe. He had shown them that the rate at which water flowed and got into wells was far different in one case to what it might be in another; and therefore in such circumstances the time element was a most important one. No matter what the strata might be, or its physical construction, there was no doubt in the question of filtration, whether it be through strata *in situ* or through material placed for the purpose of filtration, it was not sufficient that the material should be good, but the time element must apply. If the water got through the chalk at a great rate, they had no guarantee that the chalk strata would be effectual as a filtering material. In this session of Parliament, Margate and Hull were seeking powers for the protection of their areas; and he hoped there were a great many more doing the same thing. The Corporation of Southampton deposited a Bill for the purpose last year; but, unfortunately, after a good deal of expense had been incurred, they began to repent of it. They said it was a precedent, nobody else had done it; and they did not see why they should be in the van, and do things ahead of others. He (Mr. Matthews) did not see why they should not. However, he thought that it would only take a year or two for him to persuade them that it was certainly the right thing to do.

THE FUTURE OF THE LONDON WATER SUPPLY.

By R. E. MIDDLETON, M.Inst.C.E.

[A Paper read at the Surveyors' Institution, Dec. 10, 1900.]

The future of the water supply of London is of so much importance to the inhabitants of the Metropolis, that a short statement setting forth the estimated population to be provided for, the amount of water to be afforded, the sources from which it is to be obtained, and the effect of taking water from one district for the supply of another, cannot, it is thought, fail to be of interest to the members of this Institution. I am very fully aware that the task I have undertaken is difficult, and that the number and complexity of the questions to be considered are great; but I trust I may be able to put a plain story into plain words, and to brush away some, if not all, of the cobwebs which have been woven round this important subject, and show it to you as it is.

The eight Water Companies—the Chelsea, East London, Grand Junction, Kent, Lambeth, New River, Southwark and Vauxhall, and West Middlesex—supplied water to a population of 5,232,155 persons in the year 1891; while the population of Greater London, including the outlying portions of Water London, was at the same date 5,732,950, or 500,795 in excess of that included in the area supplied by the Water Companies. The population of 500,000 odd not supplied by the eight Companies is located partly within and partly without the areas of supply of these Companies, but entirely within the area of 845 square miles comprised in Greater London and the portions of Water London lying outside of Greater London, which, for the sake of simplicity, we will call "Metropolitan London," and obtains water from the following nineteen Companies, or Corporations: The East Surrey, the West Surrey, the Sutton, and the Limpsfield and Oxted Companies, the Croydon and Richmond Corporations, and the Epsom Local Board, to the south of the Thames. The South-West Suburban Company supply both in Surrey and Middlesex, and the Barnet District Gas and Water Company, the Central Middlesex, the Colne Valley, the Rickmansworth, and Hoddesdon Companies, and the Uxbridge, Cheshunt, Enfield, Tottenham, and Ware Local Boards supply in the counties of Middlesex and Hertford; while the South Essex Company supply part of Essex.

The population of Greater London (701 miles in area) was 5,659,909 in 1891, increasing at the rate of 18·2 per cent. per decennium; and that of the outlying portions of Water London (with an area of 144 square miles) was at the same period 76,041, increasing at the rate of 19·7 per cent. per decennium. The population of Metropolitan London will therefore be, following the same rate of progression, at the end of each decade—

Year.	Greater London Increasing at a Rate of 18·2 per Cent. per Decennium.	Outlying Portions of Water London Increasing at a Rate of 19·7 per Cent. per Decennium.	Metropolitan London.
1891 .	5,659,909 ..	76,041 ..	5,735,950
1901 .	6,685,445 ..	91,407 ..	6,776,852
1911 .	7,900,987 ..	109,385 ..	8,010,372
1921 .	9,337,542 ..	130,899 ..	9,468,441
1931 .	11,035,289 ..	156,645 ..	11,191,934
1941 .	13,043,712 ..	187,504 ..	13,231,216
1951 .	15,417,667 ..	224,442 ..	15,642,109
1961 .	18,223,682 ..	268,657 ..	18,492,339

The density of population in the county of London, with an area of 118 square miles, was in 1891 56·1 per acre. A population of 18,223,682 in 701 square miles would be at the rate of 40·6 per acre. With a density of 56·1 per acre, 845 square miles would contain a population of 30,338,800.

That the population of London—a city or aggregation of cities standing for the most part on an area circumscribed by a line drawn with a radius of 15 miles having Charing Cross as a centre—will ever reach a figure of 18,500,000, not to speak of 30,000,000 persons, is, to say the least of it, improbable; but prophecy on this subject would be improper, even if it were possible. If, however, it can be shown that the same sources of supply which have been sufficient in the past can, if adequately guarded and under proper treatment, be made sufficient for the future requirements of this vast population, it will be agreed that no anxiety need be felt for the immediate future; that each succeeding census will tend to prove or disprove the assumptions on which the estimate of the future population is based; and that it will be sufficient, when the population of London has reached a total of 15,000,000 persons (should that time ever arrive), to inquire whether London does or does not require any addition to its water supply which cannot be afforded by an extension of the system already adopted.

Besides the population of the Metropolis, there were in 1891, in the valley of the Thames above the intakes of the Metropolitan Water Companies near Hampton, 1,056,415 persons, increasing at the rate of 9·88 per cent. per decennium; and in the valley of the Lea above the intake of the East London Company, 189,287 persons, increasing at the rate of 14·17 per cent. Following out these figures, the population in the valleys of the Thames and Lea would in 1961 be: In the Thames Valley, 2,042,985; in the Lea Valley, 478,614—total, 2,521,599.

In the chalk area of Kent, to the eastward of the Kent Company's district, and to the north of a line drawn from Sevenoaks to Dover, but excluding the Isles of Thanet and Sheppey, which could not do more than supply their own population, there was in 1891 a population of about 379,819 persons, increasing at the rate of 11·7 per cent., which, following the same rate of increase, would make the population in 1961 in this area 824,041. In the county of Essex, the district which is increasing in population with the greatest rapidity lies within the area of 845 square miles, which we have called Metropolitan London. It is improbable that the rest of the county will be supplied to any great extent from the valleys of the Lea or the Thames, or from any district which will be called upon to contribute to the supply of the Metropolis; and it will suffice if 100,000 be added to the population in 1961, already referred to, to meet any calls in this direction.

The total population to be provided for in the future up to the year 1961, taking the rate of increase to continue as it was from 1881 to 1891, will be—

Population to be Supplied with Water.	Year.	Metropolitan London.	Valleys of Thames (*a*) and Lea (*b*).	Kent (*a*) and Essex (*b*).	Total.
6,149,551	1891	5,735,950	(*a*) 1,056,415 (*b*) 189,287	(*a*) 379,819 (*b*) 33,782	7,395,253
7,240,547	1901	6,776,852	(*a*) 1,160,789 (*b*) 216,109	(*a*) 424,258 (*b*) 39,447	8,617,445
8,530,330	1911	8,010,372	(*a*) 1,275,475 (*b*) 246,732	(*a*) 473,896 (*b*) 46,062	10,052,537
10,051,570	1921	9,468,441	(*a*) 1,401,492 (*b*) 281,694	(*a*) 529,342 (*b*) 53,787	11,734,756
11,846,016	1931	11,191,934	(*a*) 1,539,959 (*b*) 321,610	(*a*) 591,275 (*b*) 62,807	13,707,585
13,965,009	1941	13,231,216	(*a*) 1,692,109 (*b*) 367,182	(*a*) 660,454 (*b*) 73,339	16,024,300
16,465,474	1951	15,642,109	(*a*) 1,859,289 (*b*) 419,212	(*a*) 737,727 (*b*) 85,638	18,743,975
19,416,380	1961	18,492,339	(*a*) 2,042,985 (*b*) 478,614	(*a*) 824,041 (*b*) 100,000	21,937,979

Of the water supply for this estimated population of 22,000,000 in round numbers, that for the Metropolitan area in the county of Kent and in Essex passes away, after being used, into tidal waters; while that drawn from the valleys of the Thames and the Lea, for the use of the population living above Hampton and Chingford, is returned to the land and eventually to the rivers, and is therefore available for the supply of the population below. The total population to be supplied may, therefore, be reduced by 2,521,599 to 19,416,380, or (say) 19,500,000. There are breweries and manufactories, both in the valley of the Thames and the Lea, which use large quantities of water; but practically the whole of it is returned to the rivers, as the small quantity which is carried away in steam and in beer, &c., forms such an infinitesimal proportion of the whole, that it may be ignored. So far as the writer is aware, the only water which is carried away is that drawn by the London and North-Western Railway Company from their chalk wells at Bushey; and even this goes in reduction of the water used for trade purposes in London, as does the water pumped from wells in London for similar and other trade purposes.

That the requirements of the population of the valleys of the Thames and Lea above the intakes of the Metropolitan Companies can be affected by the water drawn from these rivers at Bell Weir, Sunbury, Hampton, Ware, or Chingford, or from wells sunk in the chalk at Streatham and from Ware to Barking, is not possible. Were it not that they return the water to the land or to the rivers after using it, the inhabitants of the upper reaches of the valleys of the Thames and Lea, having the first pull, could deprive those below them of water; but they themselves cannot be deprived, nor can their supply be reduced, and, as things are, neither suffers. It is the interests of those situated below the intakes and below the pumping-stations, not those above, which have to be considered; and the requirements of the former are fully safeguarded in the scheme propounded by the writer by their inclusion in the population to be supplied.

When reservoirs are formed in natural valleys for the supply of water to a particular town or district, it is usual for the promoters, who have to pay for the necessary works, to obtain powers over the drainage area down to the position of the dam, to impound all the water flowing off the drainage area, and to give back to the river as compensation for the right to abstract a certain amount of water from it about one-fifth to one-third of the available water running into the reservoir on the average of three dry years. The remainder of the water, except so much as may run away over the bye-wash of the reservoir, becomes the absolute property of the promoters. Under these circumstances, no large quantity of water can be abstracted from the river above the dam; while below the dam the flow of the river is reduced to something less than one-third of its average volume, and it is unlikely that Parliament would allow anything further to be taken from the main river, though that body might perhaps permit other reservoirs to be constructed by the same or another authority, and on similar conditions as to compensation, on one or other of its tributaries. Under the conditions referred to, neither those above nor those below the waterworks can hope to be able to draw any considerable quantity of water from the river.

The reservoirs already constructed in the basins of the Thames those in course of construction, and such as may be built in the future, are designed to be used under totally different conditions. The promoters are not empowered to take the whole of the waters

of the river, but may only pump the water into the reservoirs when it exceeds a given quantity. They can only take such surplus water as flows down to their intakes, and cannot prevent those above them from drawing water from the river for their own purposes, though no doubt they would successfully oppose the abstraction of water if it were the intention to divert it to the use of a district outside the drainage area of the Thames, and to prevent its return to that river or to land within the drainage area. The intakes to the reservoirs are situated so far from the source, and so near to tidal waters and to the Metropolis, that the population below the intakes will be provided with water drawn from the several intakes, and cannot suffer from any abstraction of water from the river, even if it were greater than is proposed; while it has been shown that the inhabitants living above the intakes would not be interfered with in any way.

In the case of impounding reservoirs—as, for instance, those proposed by the London County Council to be constructed in Wales—a given very large quantity of water would be abstracted from the area of supply for the use of London, and would be entirely lost to inhabitants of the area from which it was drawn and to those living geographically below the reservoirs.

It is calculated, on the assumption that the rate of increase existing between 1881 and 1891 is maintained, that the effective population within the area of supply—the population to be supplied with water from the sources to be enumerated hereafter—will number 19,500,000 in 1961; but the calculation is based on the merest assumption. In calculating the probable population at any given date in any of the large provincial towns, it is generally assumed that there will be a decremental rate of increase—that is to say, the rate will be less than compound and greater than simple—but whatever assumption be made, it is based on knowledge derived from the past, and is, at best, only assumption. For the present purpose, the percentage of the rate of increase will be taken as constant.

The Royal Commission presided over by Lord Balfour of Burleigh decided, after hearing a very large amount of evidence on the subject, that a supply at the rate of 35 gallons per head per diem for all purposes is ample. It has been maintained that advanced and advancing sanitation, the increased use of public and private baths, the demands for street watering, flushing of sewers, &c., necessitate a much larger use of water, and that a supply at the rate of 35 gallons per head is inadequate. The gross misuse of water which is allowed to exist in the cities of America, and the lavish supply afforded in Glasgow, and at times in Paris, have been adduced as arguments in favour of this contention; but the experience of provincial towns disproves it. It is notorious that the waste of water in America is unparalleled, that Glasgow will have to curtail its supply, and that Paris is in great straits for water at the present time; while it has been repeatedly shown that the legitimate use of water for domestic purposes in large towns does not exceed 17 gallons per head, and in country districts from 10 to 12 gallons.

The supply afforded by the Metropolitan Water Companies has, during the last three very dry years, exceeded 35 gallons per head. There can be no doubt, however, that this quantity could be very materially reduced—probably to 27 gallons per head—if the Companies enforced with the utmost stringency the powers they have, and obtained such further powers for the prevention of useless and unnecessary waste as are possessed by many provincial companies and corporations. Should the undertakings be transferred to a Trust, as recommended by Lord Llandaff's Commission, it is certain that waste would be put down with a strong hand, and that the water consumer would be brought under much more strict supervision than he is accustomed to at present. Taking the rate of supply to be that provided for by Lord Balfour's Commission, or 35 gallons per head, including that required for the rural districts—a very ample provision indeed—the average quantity of water to be supplied daily at the end of each decade will be—

	Gallons.		Gallons.
1891	215,234,285	1931	414,610,560
1901	253,419,145	1941	488,775,315
1911	298,561,550	1951	576,291,590
1921	351,804 930	1961	679,573,300

The actual increase in supply does not proceed by regular increments, but depends to a considerable extent on the conditions of each year—whether the general temperature is high or low, whether there is much or little rain, and whether the winter period is open or frosty. It is necessary, therefore, to provide for something more than the calculated requirements, to the extent of probably about 5 per cent. The greatest possible provision necessary to be made for the year 1961, supposing the population at that date to number 19,500,000 persons, would therefore be 717,500,000 gallons a day.

Before proceeding to examine into the question of how this quantity of water (more than three times the average supply at the present date) can be provided, it is necessary to clear the way by the removal of erroneous interpretations of the findings of the two Royal Commissions of 1893 and 1899, and other stumbling blocks which interfere with a true solution of the problem under consideration. It has been repeatedly stated that the report of Lord Balfour's Commission gave a verdict to the effect that only 300 million gallons a day were available from the Thames. The report of Lord Balfour's Commission contains not one word to this effect; nor does the later report of Lord Llandaff's Commission confirm the statement erroneously said to be made by Lord Balfour's Commission. On the other hand, the report says: "We do not understand Lord Balfour's Commission to have expressed any opinion as to 300 million gallons a day being the limit." We are asked to believe that Lord Balfour's Commission, on which the engineering profession was represented by Sir George Bruce (who was also a member of Lord Llandaff's Commission), Mr. Hill, and Mr. Mansergh, was deceived in its estimate of the capabilities of the Thames to supply 300 million gallons a day, or 22 per cent. of the average flow of the river. On the other hand, we are required to accept as a conclusion with which there can be no cavil, that an area of 488 square miles in Wales—only one-eighth of the drainage area of the Thames basin—can supply 415 million gallons a day without injury to the rivers; or, in other words, be nearly eleven times as productive as an equal area in the Thames basin.

It is desirable at this stage to consider what is the real value of the Thames for purposes of supply, and to compare it with the Welsh drainage area, and with impounded supplies generally. The drainage area of the Thames down to Teddington Weir is 3766 square miles, or to the Companies' intakes 3548 square miles; and the average rainfall on this area is 28·50 inches. The actual average run-off from the larger area is about 1450 million gallons a day, or 9·7 inches of rain; the average of three dry years, 1016 million gallons, or about 6·8 inches of rain; and the flow of the driest year was 644 million gallons a day, or 4·3 inches of rain. In order that the same run-off should be obtained from 488 square miles in Wales, the average rainfall would have to be approximately 90 inches; whereas it is doubtful if it is so much as 55 inches. The value of the Thames basin as an area of supply is therefore greater, not less, than that of the Welsh rivers.

The run-off from a considerable area of this district was not, on the average of two years, more than 37 inches. If the value of the whole district be taken at 40 inches of rain, its value as compared with that of the Thames is as 488×40 to $3548 \times 9{\cdot}7$ inches, or as 1 to 1·76 nearly; all the advantage being with the Thames.

I wish it to be understood that I do not pin my faith on these figures as representing the average run-off from the Welsh district; they may or may not do so. The probabilities are that, on the average of a number of years, the run-off is more than 40 inches, but not to such an extent as to materially affect the comparison with the Thames.

The least natural flow of the Thames during any month was at the rate of 212 million gallons a day. At such a time, supposing the average supply to be afforded to be 415 million gallons a day, the draft on the Thames Valley reservoirs would be 495 million gallons a day. The least natural flow in the Welsh area would be not more than 35 million gallons a day; and the draft on the reservoirs, under like conditions with those already instanced for the Thames, would be 677 million gallons a day or thereabouts, and it is again shown that the advantage rests with the Thames.

Experience has proved that impounded supplies have, when worked to their full capacity, failed to afford the quantities of water expected from them; and there is no reason to suppose that the Welsh area would be an exception to this rule. Indeed, the gaugings of one of the rivers show that, in order that the estimated supply should be afforded, the reservoir capacity would have to be largely increased. On the other hand, the Thames has been gauged for more than 16 years, during which period the rainfall has been 2 inches, or 7 per cent. below the average. The rainfall of the last $2\frac{1}{2}$ years was 23·3 inches, which is 18·3 per cent. below the average. These figures agree very closely with the rules which are accepted as governing the flow of rivers; and so far from disproving the findings of Lord Balfour's Commission, they confirm them.

In another respect the Thames has the advantage over Wales—in that, while the storage capacity requisite for a supply of 415 million gallons a day from Wales is estimated by the promoters to be 104,600 million gallons, on the terms set forth in the report of Lord Llandaff's Commission (namely, that storage may be calculated on the basis of the year 1893), the requisite storage in the Thames Valley would be only 45,000 million gallons, or 43 per cent. of that necessary to supply the same quantity of water from Wales. The flow of certain Welsh rivers has fluctuated, on the average of a month, from something like 35 million gallons a day at the lowest to 2500 million gallons at the highest, or in the proportion of 1 to 72; while the flow of the Thames varies from 212 million gallons a day at the lowest to 6400 million gallons at the highest, or in the proportion of 1 to 30. The lowest flow of the Thames is six times that of the Welsh rivers, while the highest is two-and-a-half times that in Wales.

Storage must be made use of, whether in the Thames, in Wales, or elsewhere, if the water is to be employed to the best advantage; and it is obvious that the more regular the rate of flow and the less the quantity of water to be used in comparison with the average flow off the drainage area, the more certain is the supply and the smaller the reservoir capacity to be constructed for a given supply. The advantage is with the Thames in both respects, as it is not proposed to use, for purposes of supply, more than 30 per cent. of the average flow of that river; while something like 60 per cent. of the average flow of the Welsh rivers would be abstracted for a like purpose. In the Thames, the flow is so well maintained that it is unnecessary to give compensation water to the river; while in Wales at the

time of minimum flow compensation to the extent of from 100 to 175 million gallons a day would have to be afforded, and the requisite storage increased by from 20,000 to 35,000 million gallons for that reason.

As regards cost, the comparison is again largely in favour of the Thames. In the items which are strictly comparative, Lord Llandaff's Commission found that the cost of reservoirs and appliances in the Thames Valley would be as 1 to 2·3 when compared with the like provision from Wales. I am of opinion that this is an under-estimate, and that the comparative figures should be as 1 to 2·8. The above comparisons refer to works other than those for filtration, for service reservoirs, and distribution, which must be incurred whether the supply be drawn from the Thames, the Lea, and from wells, from Wales, or elsewhere.

To return to the arguments which have been raised against the continued use of the Thames and the Lea. It has been suggested that the water derived from these rivers is polluted, and is liable to increased pollution in the future, due to a larger population. The report of Lord Balfour's Commission refutes this contention, and the freedom of London from zymotic disease nullifies it. Since the Thames Conservancy obtained their Act in 1894, there has been a reduction, not an increase, in the organic impurities contained in the water; and the knowledge obtained during recent years of the biological treatment of sewage, points to a time, not far distant, when, even in populous districts, our rivers may be freed from impurities, and be kept nearly as pure as those which run through barren tracts.

In this connection, Mr. James Mansergh, the President of the Institution of Civil Engineers, in his Presidential Address delivered on the 6th ult., called attention to the danger which may be apprehended from water derived from sources hitherto considered pure. He said: "A word of warning may be spoken with regard to water obtained from elevated and sparsely populated moorlands, for the danger is, in my opinion, greater if such water became infected, especially if not passed through impounding reservoirs, than if the supply were taken from a large river."

In order to attain the most desirable result of freeing our rivers from impurities, it would be of the utmost advantage if the existing divisions of the country into counties, unions, and parishes were, for water supply and sewage purposes, replaced by drainage areas, which could be conserved on a system similar to that of the Thames basin, but somewhat more extended in its application. Although Thames water contains more impurities of animal origin than does that flowing from the Welsh rivers, it must not be supposed that the latter is free from organic matter, or that it is invariably clear and bright.

Among many other questions which appear to be misunderstood, there is one error which requires correction. It has been stated in the Press that the area of reservoirs in the Thames Valley, to afford a supply of 300 million gallons a day, will be 10 square miles. According to the report of Lord Llandaff's Commission, the capacity of the reservoirs yet to be constructed to afford this supply should be 17,500 million gallons. The area of the Staines reservoirs to contain 3300 million gallons is 421 acres, or two-thirds of a mile; therefore, with the same depth of water, reservoirs to hold 17,500 million gallons will have an area, not of 10 square miles, but of 2233 acres, or 3½ square miles. The above calculation is based on the supposition that the reservoirs to be constructed in the future will be of similar capacity to those in course of construction at Staines; but should the reservoir capacity be increased, more water is stored on a given area, and it also becomes economical to increase the depth of water. Therefore the total future area of land to be employed for reservoir purposes up to a supply of 300 million gallons a day, is likely to be less, rather than more, than 3½ square miles. The maximum area to be occupied by reservoirs, including those already constructed or in course of construction, according to the conditions set forth in the report of Lord Llandaff's Commission, is, for a supply of 400 million gallons a day, 7½ square miles.

Having estimated that, at some date or another (which for the sake of argument, has been called the year 1961), the population to be supplied will number 19,500,000; that the rate of supply, which, supposing waste be prevented, may provide for much cleansing of streets and for public fountains, will be 35 gallons per head; and that the quantity of water to be supplied, including a reserve of 5 per cent., will be 717,500,000 gallons a day—it is required to show from what sources this enormous quantity of water, which is nevertheless half of the average flow of the Thames, can be drawn.

The area of the Thames basin down to the intakes of the Water Companies at Hampton is 3548 square miles; and the water run-off from this area during the last sixteen years has measured 8·22 inches of rain, or 1166 million gallons a day. The average rainfall during the same period has been 26·36 inches, or 2·14 inches less than the 28·5 inches which the late Professor Symons determined to be the general average rainfall in the drainage area of the Thames above London. It is not easy to determine what proportion of the 2·14 inches deficiency of rainfall during the last sixteen years would, on the general average of years, find its way into the river; but it is not likely to be less than two-thirds, which would make the general average run-off over a long period of years 9·64 inches—say, 9·70 inches. If the average run-off be 9·70 inches of rain, the average flow is 1376 million gallons a day. The report of Lord Balfour's Commission puts this figure at 1350 million gallons daily. The run-off of the Thames measured at the same point has been, on the average of three dry years, 970 million gallons a day, and during the driest year 616 million gallons daily.

Speaking generally, the amount of water drawn from the Thames during any year will approximate to the average supply. The proportion of the flow of the river taken for this purpose will therefore be, on the average of years, 30 per cent., and on the average of three dry years 40 per cent. nearly. During the driest year, the quantity of water drawn from store is so large in comparison with that drawn direct from the river as to amount probably to some 90 million gallons daily; and the average quantity drawn from the river during such a year will not exceed 310 million gallons a day, or 48·17 per cent. of the river's flow. In the Welsh rivers, supposing the proposed reservoirs to be of sufficient capacity, and a quarter of the average available flow of three dry years to be given as compensation, the proportion drawn for purposes of supply would be, on the average of years, approximately 55 per cent., on the average of three dry years 72 per cent., and during the driest year 98 per cent. It does not require any very elaborate calculation to show that the supply which is only 48 per cent. of the flow of a river, during the driest year for more than 80 years, is better secured than when 98 per cent. of the whole flow of the drainage area has to be taken to satisfy an almost identical supply.

Although it is herein accepted that, under the conditions of storage recommended by the Royal Commissions presided over by Lords Balfour of Burleigh and Llandaff, the maximum supply to be drawn from the Thames is 400 million gallons a day on the average of a year, it must not be concluded that the capabilities of the river for purposes of supply are thereby exhausted; but it becomes a serious question whether it is economically desirable to further increase the supply drawn from this source.

Lord Balfour's Commission decided that, with the introduction of adequate storage, which is in course of construction, 52,500,000 gallons a day can be obtained from the River Lea. Some 22,500,000 gallons daily are taken by the New River Company, without storage; 5,400,000 gallons daily must be provided for the use of the Lea navigation; and 30,000,000 gallons per diem are, under the above conditions, available for the East London Company. The average flow of the River Lea, as measured at Feilde's Weir, is about 120 million gallons daily, or 7·11 inches of rain run-off from an area of 422 square miles.

The average rainfall in the Lea Valley is 26·50 inches (Sir John Evans says 26·24 inches); while the average for the last sixteen years has been 23·91 inches, or a deficiency of 2·59 inches. The average run-off for the same period has been 6·31 inches of rain, equal to 106,500,000 gallons a day. The average flow of the Lea during the three dry years 1897-8-9 was 78·4 million gallons daily, and during the driest year 42·3 millions. The rainfall for the years 1862-3-4 was 21·86 inches; and the run-off was at the rate of 4·79 inches, or 80·8 million gallons a day. For the years 1863-4-5 the rainfall was 22·88 inches, and the run-off 4·48 inches, or 75·6 million gallons daily. The average ratio of the run-off to rainfall is 20·7 per cent. For the years 1893-4-5 the rainfall was 23·28 inches; and the run-off was 4·89 inches, or 82·5 million gallons a day. The rainfall for the years 1897-8-9 was 23·56 inches, and the run-off 5·23 inches, or 88·2 million gallons per diem. The average ratio of the run-off to rainfall is 21·2 per cent. These figures are corroborative one of the other; and it is shown that there is no falling off during the later period in the proportion of the rainfall which finds its way into the river.

In the report of Lord Balfour's Commission, it is stated that, on the average of three dry years, 56 million gallons of water may be pumped daily from the chalk basin of the Lea Valley without injury to any material interests, and that during the driest of three dry years 47 million gallons a day may be pumped. In corroboration of these figures, if the average rainfall be 26·5 inches, and the loss by evaporation so high as 16 inches, the available rain will be 10·5 inches, or 177,240,000 gallons a day; but the average run-off of the river is 120,000,000 gallons daily. There is, therefore, a quantity of 57,240,000 gallons a day which passes down through the chalk basin, and does not find its way into the visible river. Should the loss by evaporation be 15 inches instead of 16 inches per annum, as seems probable, the available rainfall will be 11·5 inches, or 194,120,000 gallons daily, and the quantity passing down through the chalk basin 74,120,000 gallons per diem. Having shown that the available water in the chalk basin is certainly as much as 57 million gallons daily, and may be 74 million, it is unnecessary to follow the argument further—especially as these figures confirm the conclusions arrived at by Lord Balfour's Commission.

Even supposing the pumping during the driest year to exceed the available supply due to the rainfall of that year—a contention negatived in the report of Lord Balfour's Commission—the reduction in the level of the water in the area below the pumping-station due to pumping would be very small, and in the area above the pumping-stations it would be non-existent. It is not possible to estimate with any degree of accuracy either the area of the chalk basin below the pumping-stations which might be affected by excessive pumping or the capacity of the chalk for parting with the water contained in its pores and fissures; but it is not unreasonable to calculate that a reduction of level of 1 foot over the whole area would mean the removal of some 50 million gallons of water daily. Thus excessive pumping to the extent of 10 million gallons a day, continued for a year,

would mean a reduction in level of one-fifth of a foot, or 2·4 inches. Obviously the level is not reduced, if it be reduced at all, regularly over the whole area, but is at its maximum in the line of the wells, decreasing to *nil* at a short distance above the highest pumping-station and laterally from the same station, and widening out lower down in the area. The depression may therefore reach many inches at the well, although when extended over the whole area it is very trifling. Whatever the reduction of level might be in one year of great drought, in the next year of excessive rainfall it would be made up again, and something over.

As regards the area above the pumping-station, a little consideration will, it is thought, show conclusively that the effect of pumping cannot extend beyond a limited distance. What that distance is, must depend on the nature of the material in which the well is sunk, on the depth of the well, and the level to which the water is reduced in it when pumping. In a purely chalk formation, it is believed that the effect of pumping is seldom felt at a greater distance from the well than a quarter-of-a-mile, calculated on the level. When the well is situated at the foot of a steep escarpment, this distance is likely to be exceeded. The same holds true of a chalk area covered with gravel charged with water; and it is known that the effect of pumping has been felt at a distance of a mile.

Given a well sunk to the bottom of the chalk on to the impermeable stratum below it, given engine power sufficient to pump the well to the bottom, and to continue pumping without intermission from year's end to year's end, not always at the same rate, but so as to keep the pumping level of the water in the well as near the bottom as is practicable, continuance in pumping will not extend the area of absorption, which will only vary from season to season with the level of the water in the surrounding strata. If the level of the water in the district rises, so will it rise in the well. If the level of the water in the district sinks, the water in the well cannot sink lower, for it is already at the bottom; the diameter of the cone of absorption will therefore be reduced, and the quantity of water pumped from the well will be decreased.

The same principle may be applied to a visible and uncanalized river; and an illustration drawn from such a source may appeal more readily to the mind than where underground and invisible sources are to be considered. Let a well be sunk in the middle of an uncanalized river; and let pumping machinery be provided of sufficient capacity to lift the whole of the water running down to the pumping-station at any time, and to transfer it in some other direction. Below the pumping-station, the bed of the river will be dry for some distance, until enough water accretes from the banks, from the bed, and from tributary streams to renew the flow to some limited extent. At the pumping-station the depth of the water will be reduced from what it was when the river flowed naturally down its bed. Above and near to the pumping-station, the velocity of the stream will be increased and its depth reduced; but at some distance, varying with the volume of the water and the depth of the river, the original conditions will be restored. The quantity of water to be pumped may be at the greatest 20,000 million gallons in a day, and at the least 200 million gallons; but this quantity will not be affected by the presence of the pumping-station, nor will the flow of the river be altered even fractionally by the pumping, how ever so long it may be continued, but will depend, as heretofore, on the rainfall in the drainage area.

What is true of pumping from a visible river, is true also of pumping from wells sunk into the chalk. In the river, the depth of the water is limited; but its flow being only resisted by surface friction, the gradient of approach is flat. In the chalk, the depth of the well may be great—400 feet or more—but the water having to pass through innumerable small fissures, the resistance to its approach to the well is great, and the gradient of approach is steep, probably 1 in 10 or thereabouts. But whatever the gradient may be, it remains constant so long as the vertical distance from the surface to water near the bottom of the well remains the same.

There is an undoubted popular belief (which is not, however, founded on any scientific data) that the flow of the rivers and streams in Hertfordshire is being gradually reduced in volume; the loss being ascribed to the pumping of the New River and East London Companies. When, however, it is found that a supposed falling off in the flow of the River Ver is mentioned in monastic times, that Mr. Homersham speaks of the same thing in 1852, and it is again referred to in or about 1864, all being dates antecedent to the pumping of any considerable quantity of water from the chalk basin, some other explanation of the phenomenon, if there be any to explain, must be looked for; and is to be found in the meteorological conditions of the later period referred to. Mr. Homersham probably had in his mind some former period of drought, as the year 1852 was near the termination of a period of wet seasons. But the year 1865 came at the end of twelve years of less than average rainfall; and the year 1899 terminated a similar period extending over sixteen years. As the River Ver, for instance, fluctuates in the position of its source by 5 miles, and other rivers fluctuate in a similar manner, though to a less degree, between high and low water periods, it is not perhaps to be wondered at that what happened in 1883, and again in 1897, when these rivers rose at their highest points, is lost sight of; and when some years later the source is miles lower, a fear is aroused that what happened in 1883 and in 1897 will never happen again. Exactly the same fear was felt and given expression to in 1891-2-3, yet its falsity was set forth so soon after as 1897. Nevertheless, so wedded have the people become to an unfounded belief, that the same story is produced in 1898 and 1899.

Some words of apology are necessary for the length to which this argument has been followed; but as it is desired to show conclusively that the districts from which the water supply of the Metropolis is to be drawn will not be injuriously affected by its abstraction, it is necessary to go into the matter in some detail.

The chalk area in the Thames basin above the intakes of the Water Companies is 1005 square miles, which may probably be increased to 1400 square miles by areas which drain on to the chalk. Following the figures of the basin of the Lea, where the area contributing to the chalk is 352 square miles, if this area can afford 47 million gallons a day during the driest year, 1400 square miles will supply 187 million gallons a day. But the rainfall in the Thames Valley is 28·5 inches, or 2 inches greater than that of the Lea, and the yield of the chalk area must be raised in the same proportion to 201 million gallons a day. The report of Lord Balfour's Commission says that any such abstraction will probably be at the expense of the springs and streams feeding the Thames. Against this contention, it may reasonably be argued that the conditions in the two valleys are identical; and on this basis it can be shown that this or a larger quantity is available.

The area of the Thames basin is 3766 square miles, the average rainfall 28·50 inches, and if the loss by evaporation be taken on the average at 16 inches, the run-off should be 12·5 inches. The actual run-off is, however, 9·7 inches. Therefore there are 2·8 inches of rain on an area of 3766 square miles—equivalent to a quantity of 422 million gallons a day—absorbed into the ground, but which does not find its way into the river, and is available for supply without injury to the river.

On the average of three dry years, the rainfall will be 24·5 inches; and taking evaporation at 14·8 inches, the run-off should be 9·7 inches. It is, however, about 6·8 inches. Therefore 2·9 inches, or 437 million gallons a day, are available. During the driest year, the rainfall is about 21 inches; and taking evaporation at 14 inches, the run-off should be 7 inches. It is, however, 4·3 inches. Therefore 2·7 inches, or 407 million gallons a day, are available for supply; and it is shown that the estimate of 200 million gallons daily, derived from a comparison of the Lea Valley with that of the Thames, is a conservative one.

From the Kent Company's district, Lord Balfour's Commission estimated that 27½ million gallons a day may be pumped; and from the chalk area of Kent outside the Kent Company's district, 123 million gallons daily. Besides the areas referred to, there are others in Sussex, Surrey, Hampshire, and Wiltshire, from which an additional supply might be procured, which would considerably augment the available sources to which special reference has been made, and which are—

	Million Gallons a Day.
From the River Thames	400
From the River Lea	52½
From wells in the Lea Valley	47
From wells in the Kent Company's district	27½
From wells in Kent outside the Kent Company's district, say	110
From wells in the Thames Valley	200
Total	837

The sources of supply tabulated above, without consideration of those which exist in Sussex, Surrey, Hampshire, and Wiltshire, are therefore sufficient for the supply of a population of nearly 24 million persons with 35 gallons of water per head per diem, and are much more than enough to supply the population which, on the basis of calculation adopted by Lord Balfour's Commission, might possibly have to be provided for in the year 1961, or more than 60 years hence.

It is hoped that sufficient has been said to prove that the sources of supply within a moderate distance from London are more than enough to provide water for any population which may reasonably be expected to be congregated within the Metropolis, while providing amply for the requirements of the areas, other than those above the intakes of the Companies, from which the supply will be drawn. When the population to be supplied numbers, say, 15 million persons, and is still growing, it will be time enough to consider whether an additional quantity of water should be looked for from Sussex, Surrey, Hampshire, and Wiltshire, from Wales, or elsewhere.

It has been shown that the population above the intakes of the Water Companies will not be injuriously affected by the requirements of the Metropolis, however large they may become; while the interests of the inhabitants within the area of supply and to the eastward of the intakes are safeguarded, along with those of Metropolitan London itself.

It can be proved conclusively that the bringing of water from Wales of different quality, but no better than that which can be provided from the neighbourhood of London, would be very much more costly than to extend the sources already brought under contribution; while it seems more reasonable to use up the nearer supplies first, rather than to go for a limited quantity to Wales, and then be obliged to supplement it from the Thames and from wells afterwards. I have been obliged to omit much

of the proof from my arguments. I believe, however, that the more this momentous question is investigated in a spirit of pure research, the more fully will the conclusions which I have submitted be confirmed in all their bearings.

GAS-ENGINES IN ITALY.

According to some particulars recently published in the "Bollettino delle Finanze, &c.," there were a short time since about 3000 gas-engines in use in Italy; representing a total of 16,470-horse power. Of this number there were only 174 motors using poor gas; their total horse power being 5474. All the others were driven by illuminating gas. These motors were found in 220 communes (about 2·66 per cent. of the total number of communes in the kingdom). There are gas-engines in nearly all the provinces, of which there are more than a hundred. In Milan, there are 691; in Turin, 469; in Rome, 200; in Genoa, 182; in Naples, 160; in Firenze, 143; and in Bologna, 116. The provinces occupying the first rank for horse power are: Milan, 2572; Turin, 2100; Genoa, 1368; Bari, 1322; Rome, 1266; Naples, 828; Firenze, 795; and Palermo, 769. The total horse power for all the other provinces is a maximum of 500. With regard to the industries which make the most use of gas-engines, the foodstuff factories take the lead with 248 per 1000 of all the motors, and more than 226 per 1000 of all the power. In this class are particularly conspicuous the factories of alimentary pastes and those of gaseous and mineral waters, bakeries, flour mills, and tinned and salt meat works. The services connected with public works follow with 129 per 1000 of the total power; the drinking water service being remarkable for the number of motors employed, and also that for the production and transport of power for electric lighting. The printing and cognate industries employ 114 per 1000 of the total power of Italian gas-engines. Next come the mechanical industries, especially foundries, machine building or repairing works, &c., with 101 per 1000; then the physical industries, with 74 per 1000; and the timber industry, with 46 per 1000. A less important, though not uninteresting classification—viz., that by numbers—gives the following order for the various industries: Foodstuffs, printing, &c., mechanical engineering, public services, timber industry, &c. As regards motors operated with producer gas only, more than one-half of them are employed by the foodstuffs industries and public works—viz., 96 out of 174, with 3397-horse power out of 5473.

REGISTER OF PATENTS.

Preparing Carbide of Calcium.—Toby, F. L., of Euston Square, and Borch, O. S., of Upper Bedford Place. No. 23,874; Nov. 30, 1899.

The inventors claim a process by which preparations of carbide of calcium are produced, containing "particles," which conduct the water to the carbide, and "thereby assure a constant access of water to the carbide when desired;" also a process by which different carbide of calcium mixtures can be produced having different degrees of quickness in generating gas, to suit different apparatus. It is asserted that these mixtures of carbide of calcium, on being decomposed, do not produce after-generation, and no incrustation takes place at any time during generation.

This is brought about by a thorough intermixing of the carbide of calcium with a strongly hygroscopic substance—chloride of calcium ($CaCl_2$) or chloride of zinc or magnesia. The proportions are about 7 lbs. of chloride of calcium to 90 lbs. of carbide of calcium, for mixtures to be used in ordinary acetylene lamps. The proportion of chloride of calcium can be reduced, if a mixture with a slower generation is desired, and increased if mixtures generating gas more rapidly are required. As soon as the supply of water is discontinued, the water contained in the lime-sludge is retained by the strongly hygroscopic chloride of calcium. Moreover, the undissolved carbide of calcium is coated with moist chloride of calcium sludge; but when water is again supplied, it is quickly conducted to the carbide, and the lamp can be relighted at once.

To make the mixture, chloride of calcium is heated until it assumes a liquid form. It is then transformed into an absolutely dry mass, by evaporation. A quantity of the chloride of calcium so obtained, and a quantity of carbide of calcium (in the proportion of 7 lbs. of the former to 90 lbs. of the latter), are put together into a grinding machine having air-tight receptacles, and ground into fine powder. It is advisable to pour (say) 1 lb. of oil over the above quantity of carbide of calcium before grinding it, so as to prevent any ignition of gas during the grinding process by friction. To the powder so obtained is added tar—say, 2 lbs. for 90 lbs. of carbide of calcium; and the whole is thoroughly mixed, and heated to (say) 120° C., and then passed through a sieve. The mixture is then left to cool down—preferably for a few days in closed receptacles. It is then passed into a briquette machine, and compressed into cakes of any required size.

If it is desired to make mixtures which generate gas less quickly, the proportion of chloride of calcium is reduced to (say) 5 lbs. or less; and an increase in the proportion of chloride of calcium to (say) 15 lbs. will produce very rapid generation.

Production of Carburetted Air Gas.—Boult, A. J.; a communication from A. Perrier, of Marseilles. No. 25,009; Dec. 16, 1899.

This apparatus (for the production of petroleum or like gas suitable for lighting, heating, or as a motor-driving means) consists of three main parts—*i.e.*, an air-vessel or compressor, a saturator, and a gasholder; the two first-mentioned apparatus alone forming the main object of the invention.

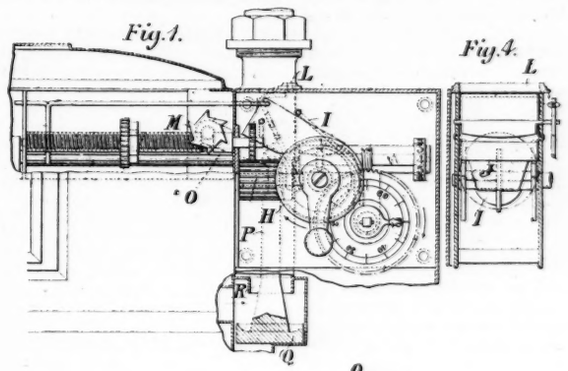
The air to be carburetted is supplied through a bell placed in a water receptacle, and capable of moving up and down in it; the bell being caused to descend in order to drive the air under pressure through saturators preferably formed of several chambers, arranged one above the other, and each supplied separately from a petroleum reservoir arranged above. The air flows through the charge in these chambers, takes up vapours therefrom, and thus saturated passes to the gasholder ready for use.

Prepayment Gas-Meters.—Paterson, B., of Clerkenwell Green, E.C. No. 1086; Jan. 17, 1900.

This invention relates to coin-freed gas-meters of the kind wherein, by the aid of a coin, a normally locked handle is freed to enable the purchaser to turn it through a predetermined distance; the rotation of the handle revolving a screw, and setting forward a toothed wheel upon it through a predetermined distance, and opening the gas outlet or inlet valve so as to allow gas to pass through the meter—the passage of the gas effecting the return of the toothed wheel by means of an elongated pinion placed parallel with the screw.

Fig. 1 is a sectional elevation of a portion of a meter with the present improvements applied to it. Fig. 2 is a sectional plan. Figs. 3 and 4 are cross sections. Fig. 5 is a view similar to fig. 3, but showing the parts in different relative positions.

The prepayment mechanism comprises the carrier for receiving the coin



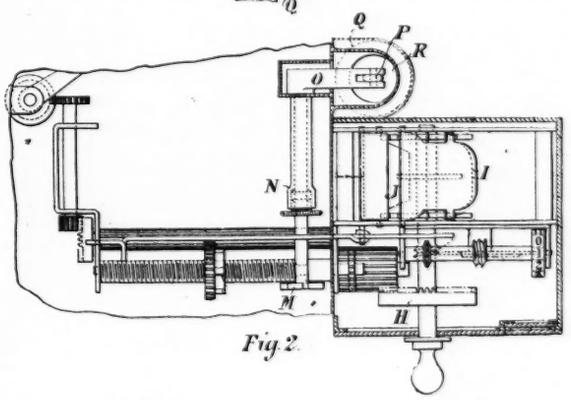
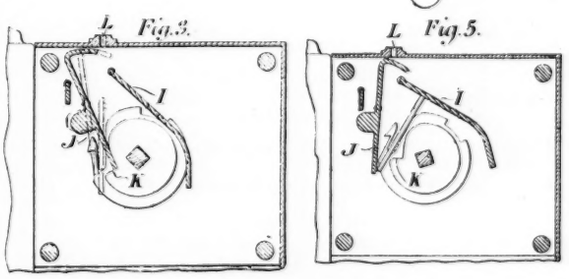


Fig. 2.



introduced, consisting of two end-plates, formed with slots to receive the coin, and mounted upon a spindle which is supported in bearings in the frame-plates, and has an external handle or crank whereby it can be turned in the usual way. The spindle is provided with a crown-wheel H, which gears with an elongated pinion adapted to effect the rotation of the feed-screw either directly or indirectly. In the arrangement shown, it actuates the screw through the medium of a toothed wheel mounted upon one end of the feed-screw externally to the meter-casing and inside the casing of the prepayment mechanism. The wheel H also serves as a price-changer—to enable the apparatus to be adapted to deliver different quantities of gas for each coin inserted according to the price of gas. The coin-carrier is normally held against rotation by means of a pawl I having two pins, which engage peripheral notches or slots in the end-plates of the carrier by means of a second or gravity-pawl J, which normally engages a depression or tooth K upon a cam-disc extended upwards to form a shutter for closing the coin-slot L, when a coin is in the carrier. It will also be seen that the pawl forms a guide for the coins inserted.

With this arrangement, when a coin is inserted in the apparatus, it drops into the slots in the end-plates, and in its travel releases the gravity-pawl J from engagement with the cam-disc, moving it into the position shown in broken lines in fig. 3, so that the shutter is brought underneath the coin-slot L and closes it. The cam-disc being thus released,

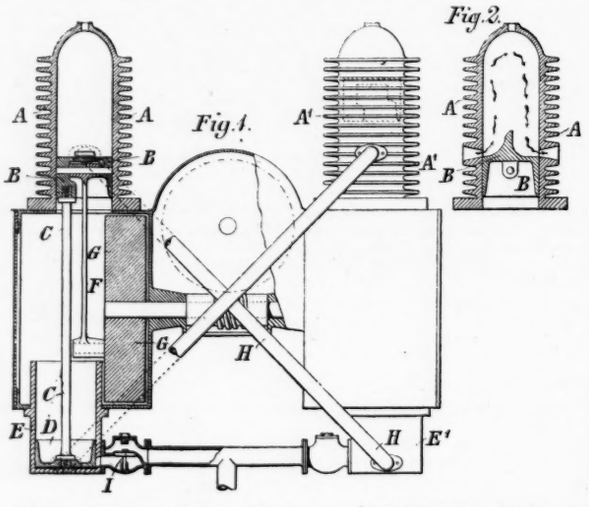
the carrier can be rotated slightly. This initial movement of the carrier, however, causes the coin to lift the pawl I from the peripheral notches, as shown in fig. 5, thereby completely releasing the carrier, and allowing it to be turned further until the coin falls from the carrier and the latter resumes its normal position. The gravity-pawl (which, during the latter portion of the movement, has ridden upon the periphery of the cam-disc, and thereby kept the money-slot closed) then again drops into engagement with the tooth K, and locks the carrier, upon which the shutter is withdrawn and the money-slot L reopened to receive another coin, and so on. The rotation of the spindle has turned the crown-wheel H, which, through the medium of the toothed gear, has set forward the toothed wheel upon the screw to an extent corresponding to one coin's equivalent of gas.

The toothed wheel in the attic of the meter is of special construction—that is to say, it is formed upon one face with a number of projections or teeth (preferably somewhat radial); the grooves forming the teeth upon the wheel extending on to the peripheries of the projections. These teeth have for their object to engage with a star-wheel M, when the toothed wheel has been returned by the action of gas passing through the meter to the initial position; the engagement of the teeth at any point with the star-wheel effecting the closing of the gas outlet or inlet valve. To this end, the wheel is mounted upon a spindle supported at one end in a stuffing-box N on a closed chamber containing a crank-arm O, keyed to the spindle and connected to the valve spindle or stem P, and at the other end in a recess in the feed-screw. To enable the gas to be gradually and not suddenly cut off, the valve-stem is formed with a cone-shaped lower end having a dish-shaped or recessed disc or valve proper Q. With this arrangement, the gradual closing of the valve decreases the area of the gas-outlet passage R until the disc Q completely shuts the passage.

Gas-Engine.—Melhuish, A. G., of East Dulwich, S.E. No. 1358; Jan. 22, 1900.

This invention consists primarily in arranging a duplex gas-engine in such a manner that two ignitions and explosions occur at each revolution, there being no valves in (preferably) the working cylinder, the exhaust being sucked out by a suction-cylinder of the adjoining engine of each pair. The new charge enters the cylinder at the extreme outstroke, and is deflected inwards and sweeps out the remainder of the combustion products. The return-stroke of the suction-piston discharges the products through a valve either in the piston or cylinder side; and the working piston compresses the charge, and fires it.

Fig. 1 is a side sectional elevation, showing the pipes communicating



with the respective cylinders. Fig. 2 is a sectional elevation of the working cylinder; the piston having a projection for deflecting inward and sweeping out the remainder of the combustion.

A A^1 are the working cylinders, the pistons B of which are connected by rods C to the exhausting-pistons D working in the cylinders E E^1. The piston B, by the connecting-rod F, imparts rotary motion to the fly-wheel and crank-disc G, which can be utilized in doing work in any convenient manner. The pistons of each engine are connected to the crank-disc at an angle of 180° to each other; so that when the one has completed its instroke, the other has completed its outstroke. Therefore, the lower or exhausting cylinder of the right-hand engine is connected by a pipe H to the top cylinder of the left-hand engine, and *vice versâ*; and the lower cylinders are either each fitted with non-return valves I, or else the pistons may be made of such a length that the valves are dispensed with.

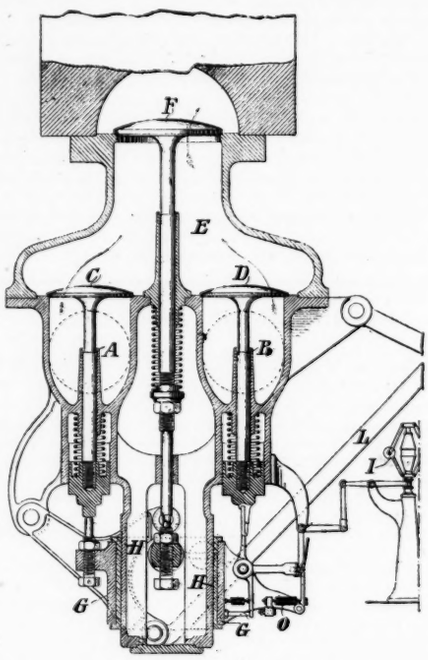
Upon the upstroke of either engine, a vacuum is formed in the lower cylinder E E^1 respectively; and when the top piston B has uncovered the communicating-port, the products of combustion are withdrawn, and a new charge enters at the opposite port, and is deflected as shown in fig. 2.

Producing a Homogeneous Explosive Mixture of Gas and Air in Gas-Engines.—Dudgeon, A. J.; a communication from La Société Anonyme John Cockerill and H. Savage, of Seraing, Belgium. No. 14,343; Aug. 10, 1900.

One of the causes which is most frequently prejudicial to the working of engines operated by the explosion of a mixture of air and gas is—the patentees point out—the want of homogeneity of the mixture. It is generally believed that the diffusion is, in itself, sufficient to assure an intimate and homogeneous mixing of the separate volumes of air and gas which are admitted into the combustion-chamber at each fixed period of the cycle of the engine. With the usual arrangements, in which air is directly admitted from the atmosphere independently of any mechanical regulation, the homogeneity of the gaseous mixture cannot be obtained, they seek to demonstrate.

They say: On what cycle soever the motor works, let us assume the position of the piston at the start to correspond with the back dead-centre, and the displacement to take place in front thereof. The admission of gas to the combustion-chamber is regulated by the distributing valve or valves, which open to the gas a certain area of the port for a given time. The volume of gas admitted depends upon these two conditions, and upon the pressure existing in the pipes—modified, perhaps, within certain limits, by the governor of the engine. The admission of the air required for the combustion of the gas is, on the contrary, not subject to any regulation. For all possible speeds and conditions of running, it depends only upon the area of the orifice establishing communication with the atmosphere, and on the displacement of the piston, which always sucks practically the same quantity of air into the cylinder. Therefore, one cause of irregularity in the composition of the mixture lies chiefly in the different modes of admission of the air and gas. Also, a further cause of loss of homogeneity is due to the variable speed of the piston. In all machines where the rectilineal movement of the piston is converted into rotary movement of the shaft or crank, the piston speed is *nil* at the dead-points, and attains its maximum at half-stroke.

Starting from this postulate, let us consider first what takes place in admitting gas to the cylinder. The admission-valve presents at the commencement of the stroke a very small opening for the admission of gas, which opening gradually increases in area correspondingly with the advance of the piston. The engine being at full speed, the quick start of the piston from the beginning of the stroke, combined with the small area of the admission-port, throttles more or less the admission of the gas. This throttling disappears with the gradual opening of the valve; and at its greatest opening (*i.e.*, at mid-stroke), the piston, having attained its maximum velocity, sucks in the gas in great volume. Towards the end of the stroke, the valve closes; the piston speed diminishes; and the gas supply is gradually cut off.



Examining now what takes place at the air admission. The air is admitted by an orifice which is fully open during the whole piston stroke. The volume drawn in depends upon the variations of speed of the piston; but, contrary to what happens with the gas entry, there is no throttling of the area of the port either at the commencement or at the end of the stroke. On the contrary, it is at about mid-stroke—when the air ought to flow at greatest speed through a passage of constant area—that a certain throttling of the air-current occurs. Air, therefore, enters in large volume towards the end of the stroke, and in less volume about mid-stroke.

The above being the conditions, let us assume that the interior of the motor cylinder (filled with its charge of explosive mixture) is divided into sections by planes parallel to the piston-face. Then the section nearest to the end of the cylinder will contain an excess of air, and those about the middle of the cylinder an excess of gas. It would be erroneous to suppose that the action of the diffusion or the compression caused by the return of the piston would be sufficient to establish homogeneity of the mixture—the diffusion only takes place slowly, especially in the case of gases of different densities; and the compression, though rendering more intimate the mixture of air and gas, does not effect complete and perfect homogeneity. This imperfect homogeneity of the gaseous mixture causes, on firing: Incomplete combustion; diminished effect of the explosion, owing to the presence of inert gases; a reduced force on the piston; and, lastly, a reduction of power developed, and a great consumption and waste of gas.

The present invention has for its object to obviate the defects referred to; and one arrangement for the purpose is shown in the engraving.

In the engine-casing are formed admission-orifices, A for the air, and B for the gas, controlled inside the casing by valves C D, held down upon their seats by spiral springs. The mixing of the gas is effected in the chamber E, into which open the two valves C D; and the admission of the mixture to the motor-cylinder is controlled by the large valve F of similar construction to C and D. The opening of these three valves is determined by the motions of a sleeve G, which is mounted to slide on a

cylindrical guide H cast in one piece with the valve-casing and adapted to act upon the valves C and F through the medium of adjustable studs. The valve D is worked by means of a detent controlled by a centrifugal governor I or other such appliance. The governor acts on the bell-crank lever K, and by means of a cam or inclined plane or other suitable connection on the latter, it raises one end of the horizontal arm, and in so doing tilts backwards the detent, which is thus thrown out of gear with the projection on the valve. By the same motion, the outer end of the arm is lifted on to a catch on the vertical curved lever, and is there maintained by the tension of the spring O. The detent is thus held in its out-of-gear position until the curved prolongation of the lever, following the ascending motion of the sleeve G, is brought into contact with a roller or button on the pivot. This releases the catch at the end of the horizontal arm, and a second spiral spring draws the tail-piece hard up against a fixed stop, so bringing the detent back to its vertical or gear position, when the gas-valve D is at once raised as the sleeve G rises. The lever L transmits its motion to the sleeve G, and therefore regulates the distribution of the charge to the motor.

When an air-regulator is employed, the action of the detent gearing is practically identical with that above described, but adapts itself better to hand regulation.

The opening of the gas-valve D is regulated according to the speed of the machine by the reciprocating movement of the sleeve G, and by the position imparted to it by the governor and the detent; the mechanism being, in fact, analogous to that employed in steam-engines with automatic gear.

The mixing of the air and gas takes place in the chamber E; and on opening the valve F, the gaseous charge rushes into the combustion-chamber in proportions which do not alter throughout the whole piston stroke. By regulating (as required, by means of the screw and nut) the opening of the valve C, air will be admitted "with certainty and constancy" during the whole stroke, in just the volume necessary for perfect combustion; and consequently "the maximum useful effect with a minimum consumption of gas will be assured."

Burners for Gas used in Furnaces.—Fletcher, T., Neil, A., and Fletcher, Russell, and Co., Limited, of Warrington. No. 15,501; Aug. 31, 1900.

This invention relates to the bunsen or similar burners used in small blast-furnaces—especially those fitted with crucibles, and employed for experimental purposes; the object being to protect the wire gauze of such burners from damage caused by the excessive radiation of heat from the interior of the furnace, when the blast is shut off, and also to remove the flame from the surface of the gauze.

For this purpose, to the inner end of the burner there is fitted over the wire gauze (on the side next to the furnace) a protecting hollow cone of cast metal, either plain, stepped, or corrugated; the larger end of the base of the cone resting with its edges against the back of the wire gauze, and the smaller end thereof projecting into the furnace.

APPLICATIONS FOR LETTERS PATENT.

22,470.—Berend, O. A., "Gas lighting." A communication from J. R. Schauer. Dec. 10.
22,491-2.—Carpenter, C., "Incandescent gas-burners." Dec. 10.
22,507.—New, A. G., "Internal combustion engines." Dec. 11.
22,520.—Hammond, J., "Gas cooking-stoves." Dec. 11.
22,546.—Bergmann, T., "Gas-engines." Dec. 11.
22,551.—Puplett, S., "Exhausting and compressing gases." Dec. 11.
22,587.—Thompson, W. P., "Self-igniting gas-lighters." A communication from Wolff and Co. Dec. 11.
22,595.—Fillet, J., "Carburetting air." Dec. 11.
22,598.—Wise, W. L., "Gas-meters." A communication from the Aktien-Gesellschaft für Automatische Zünd und Lösch-apparate. Dec. 11.
22,601.—Wise, W. L., "Lighting and extinguishing jets of combustible fluid." A communication from the Aktien-Gesellschaft für Automatische Zünd und Lösch-apparate. Dec. 11.
22,618.—Harris, W., "Shock-proof fitting for use with incandescent gas lighting." Dec. 12.
22,643.—Humfrey, C., "Producer gas-burners." Dec. 12.
22,644.—Humfrey, C., "Washers for use with producer or other gases." Dec. 12.
22,645.—Humfrey, C., "Grates, stoves, and ranges heated by gas." Dec. 12.
22,693.—Rowbotham, W. & K. A., "Gas and oil engines." Dec. 12.
22,694.—Lery, J. B. de, "Incandescent gas lighting." Dec. 12.
22,720.—Blakey, J. W., "An improved lighting apparatus for gas and other purposes." Dec. 13.
22,721.—Blakey, J. W., "Anti-vibrator for incandescent gas lighting." Dec. 13.
22,724.—Warwick, R., "Incandescent gas-lamp chimneys." Dec. 13.
22,738.—Chandler, S. S. & S. B., "Gas washers and scrubbers." Dec. 13.
22,782.—Clark, W. W., and Bone, G., "Generating acetylene gas." Dec. 13.
22,784.—Blackstone, E. C., Carter, F. & E., "Cooling the cylinders of explosion engines." Dec. 13.
22,786.—Wilson, J., "Incandescent gas lighting." Dec. 14.
22,790.—Rowbotham, W. & K. A., "Explosion engines." Dec. 14.
22,810.—Marchant, G. M. & W., "Valves for steam, water, gas, or other purposes." Dec. 14.
22,831.—Kennedy, R., "Coin-prepayment mechanism for meters." Dec. 14.
22,858.—Cross, F. W., "Combined coal-screen and coal-breaker for inclined retorts." Dec. 14.
22,894.—Lane, H., "Air and gas and like engines." Dec. 14.
22,903.—Cowan, W., "Prepayment gas-meters." Dec. 14.
22,943.—Crossley, W. J., and Atkinson, J., "Treating the gas given off from gas-producers, and the air before passing it into the producer." Dec. 15.
22,960.—Shackleton, J., and Ross, A., "Acetylene generators." Dec. 15.

LEGAL INTELLIGENCE.

HOUSE OF LORDS.—Monday, Dec. 17.

(*Before the* Lord Chancellor, *and* Lords Shand, Davey, Brampton, James, *and* Robertson.)

J. E. H. Andrew and Co., Limited, v. British Motor Company, Limited, and Others—Question as to a Gas-Engine Starter Patent.

This was an appeal by the plaintiffs against a judgment of the Court of Appeal reversing a decision of Mr. Justice Kekewich given in a case which came before him on Jan. 24, 1899.* The action was brought in the first instance for the purpose of obtaining an injunction restraining the present appellants from infringing letters patent granted to Frederick W. Lanchester. The validity of the patent had been certified by Mr. Justice Wright in an action in which Mr. Lanchester and the respondents were the plaintiffs and Messrs. Richards and Green the defendants. The appellants denied infringement, and alleged that the patent was invalid for various reasons. It related to an improved means of starting gas-engines—an operation which, prior to the invention, was, in the case of engines of great power, a work of difficulty and danger. Mr. Justice Kekewich did not express any opinion as to the validity of the patent, but held that the appellants had not infringed it, and dismissed the action. The Court of Appeal decided that the patent was valid, and that the appellants had infringed it; and they discharged the judgment of the learned Judge, and granted an injunction. Hence the present appeal. Their Lordships now delivered a reserved judgment.

Lord Davey said the case resolved itself into a question of the right construction of the first claim in Lanchester's patent of 1890. On the one hand, the respondents admitted that if the construction was that approved by Mr. Justice Kekewich, there was no infringement of their patent by the appellants; and, on the other, the appellants admitted that if the larger construction which found favour in the Court of Appeal was adopted, their machine was an infringement, subject to any question which might then arise as to the validity of the patent. The question thus presented was one of some difficulty and nicety; but he had ultimately come to a clear conclusion that the judgment of Mr. Justice Kekewich was right, and ought to be restored. The learned Judge had discussed the question very fully, and, speaking generally, he (Lord Davey) agreed with the reasons given for his opinion. The question was whether the words "causing the velocity of outflow to fall short of the velocity of the propagation of flame" would, having regard to the context, cover and include a device suggested in the body of the specification whereby the same result—viz., the striking-back of the flame—was secured automatically. First, he observed that, in the general description of the invention, as well in the provisional and in the complete specification, the patentee said it consisted substantially (so far as was material for the present purpose) "in providing means whereby, on cutting off or reducing the supply of inflammable gas or vapour, the said mixture is exploded to start the engine;" and he described a cock to be used for the purpose, "when the explosive mixture burns with a characteristic roar in the expanding nozzle." Secondly, he described an alternative method in these words: "The relative areas of the nozzles may be such that the flame, instead of being caused to strike back by reduction of the rate of flow, strikes back on the mixture becoming sufficiently rich." In the Court of Appeal, Lord Justice Romer said the patentee intended the subsidiary methods to come within the scope of his invention and the wording of his first claim. With the greatest respect to the learned Lord Justice, this assumed the very point to be decided. On the construction of the claim, he (Lord Davey) came to the conclusion that the patentee thought it more prudent not to claim, or, at any rate, had not claimed, as part of his invention for which he sought protection, the alternative means adumbrated in one sentence of his specification. It was therefore necessary to discuss the other questions argued at the Bar. He thought the judgment of the Court of Appeal should be reversed and that of Mr. Justice Kekewich restored, with costs in the Court of Appeal and this House.

The Lord Chancellor and the other learned Lords concurred.

HORSHAM PETTY SESSIONS.—Saturday, Dec. 15.

(*Before Mr.* R. H. Hurst, *Chairman, Sir* W. Stirling-Hamilton, *Bart., and Mr.* J. Warren.)

The Complaints of Nuisance from the Horsham Gas-Works.

The summons taken out by the Horsham District Council against the Gas Company for permitting noxious odours to escape from their works, which was before the Bench on the 28th of July last (*ante*, p. 294), came on again for hearing.

Mr. C. J. B. Hurst represented the Council; Mr. G. F. Hohler appeared for the Company.

The Chairman explained that, as left at the previous hearing, the case stood as follows: The Bench found that there was evidence of a nuisance arising from the Company's new works; and they postponed their final determination for three months—the Company in the meantime to raise the chimney-shaft to such an extent as would be sufficient to abate the nuisance.

Mr. Hohler gave a brief outline of the proceedings at the July sitting, and said that since then the Company had adopted the best practicable means to remedy the nuisance. Mr. Corbet Woodall, who gave evidence on the previous occasion, had suggested the raising of the shaft to a further height of 20 feet, and had also recommended that if the system of cutting off the oil supply was adopted, the nuisance would be abated, and there would be no reasonable cause for complaint.

Mr. *Corbet Woodall* was then called, and said his suggestion had been carried out in its entirety. The interval allowed in cutting off the oil was two minutes. He recommended this, but found that it was exactly what had been done. He had inspected the works, and found great care

* See "Journal," Vol. LXXIII., p. 248.

and attention paid to cleanliness and order. They were the best of the kind he had seen, for their size. He was quite sure that with the apparatus as it was now it could only be by carelessness or accident that a nuisance could be caused to the neighbourhood. He then explained the system of gas-making to the two Justices who were not on the Bench at the previous hearing.

In cross-examination, witness said 20 feet was just about as considerable an addition as could be made to the shaft with safety; and it was now high enough to prevent the probability—and almost the possibility—of nuisance to the neighbourhood. In addition to raising the shaft, he had had a wind-guard placed facing the south-west on the leeward side, so that when a south-west wind blew the gas coming out would be still further distributed in the air—not driven straight in front of the wind.

In re-examination, witness said the actual height of the shaft from the ground was now 72 feet, and its diameter 18 inches. There had been no suggestion that the diameter should be greater. If it were, they might get a down-draught, and the fumes would escape into the generator-room. A brick shaft would induce risks greater than any at present existing, for there would be liability to explosions.

Mr. HURST admitted that, since the chimney had been raised, there had been less nuisance, but said it had not been proved that this was due to increasing the height, or to the fact that the works had not been used so much. The shaft was not, he contended, sufficiently raised to carry the fumes right away over the houses; but if it were taken up still farther, it would do so.

Dr. *Kenneir*, who gave evidence on the previous occasion, said that his house was about 70 yards from the new works, and since the shaft had been raised he had not been subjected to the nuisance so often; but when the works had been going, and the wind had been from the west, it was just as bad as before. He had made notes of the nuisance, one being to the effect that on the 19th ult. the gas-works were smelling badly, and that dense yellow fumes were coming out of the top of the shaft.

In cross-examination, witness said that when the works had been going there had been no improvement whatever. However high they raised the chimney, there would always be a stench. To get rid of the nuisance they must get rid of the works. Reading further from his diary, witness said that the 4th of December was "a horrible day; abominable smells from gas-works; children made sick and bad." On the 29th of October he entered: "Gas smelling badly. Blue fumes coming out of roof."

Mr. *G. W. Flint*, Managing Clerk to a local solicitor, said his room was close to the works, and he had not smelt fumes from the shaft since it had been raised.

Mr. HURST said the shaft had been carried sufficiently high to take the fumes over witness's employer's place, but not over Dr. Kenneir's.

Mr. *Woodall*, recalled, said he had no hesitation in stating that the same quantity of gas made by the ordinary process, with coal, must necessarily produce far more smell than would arise in the production of carburetted water gas. From this gas there was no smell except that caused by the combustion of the coke.

In reply to the Bench, witness explained that the fumes coming out of the roof were caused by the removal of clinkers from the boiler in the process of cleaning. This would occur about three times a day.

Mr. *E. T. D. Sapey*, Manager of the works, said the boiler was cleared about three, and occasionally four times a day.

The Magistrates then retired. After a brief consultation, they returned and gave the following decision: "The Court finds that the Company have complied with the terms of the previous order, and therefore makes no further order against the Company."

The Liability for the St. Helens Explosion.

In the Queen's Bench Division of the High Court of Justice last Wednesday, Mr. Justice Bucknill had before him for further consideration and judgment the case of *The St. Helens Corporation v. The United Alkali Company, Limited*, recently tried by him at the Liverpool Assizes (see *ante*, pp. 1463, 1525), in which the plaintiffs sought to recover for damage done to their gas-works and other property by an explosion of chlorate of potassium at the defendants' works at St. Helens, on May 12, 1899. Mr. Danckwerts, Q.C., Mr. Clarke Hall, Mr. Rigby Swift, and Mr. Hutchinson appeared for the plaintiffs; Mr. Joseph Walton, Q.C., and Mr. Horridge represented the defendants. Mr. Walton addressed his Lordship, and claimed that, as the experts, as was proved in the case, were not aware that chlorate of potassium in a pure and unmixed condition was explosive, the defendants could not be held to be liable for the damage done. Without calling on the other side, Mr. Justice Bucknill said that it was well known that potassium chlorate was dangerous when it came into contact with other substances—notably burnt or charred wood; and in the event of a fire it was highly inflammable. The Jury at the trial had found that, in view of this fact, the defendants had not taken proper precautions against an outbreak of fire. He must, therefore, hold that they were liable; and he would give judgment for the plaintiffs, with costs—the damages to be assessed as agreed to between the parties. A stay of proceedings was granted, after some discussion, with a view to an appeal.

Damages for Personal Injuries.

At the Marylebone County Court, on Monday last week, before his Honour Judge Stonor and a Jury, John Blackman, of Warrington Road, Notting Hill, brought an action, under the Employers' Liability Act, against the Gaslight and Coke Company, for compensation for personal injuries alleged to have been caused through negligence for which the defendants were responsible. The amount of the claim was set down at £195. Mr. A. Hutton appeared for the plaintiff; Mr. Alexander Neilson represented the Company. In opening the case, Mr. Hutton explained that the plaintiff had been employed by the defendant Company as a labourer for some five years at their Kensal Green station. At these works there were twelve purifiers; and on the 13th of October the plaintiff was assisting in cleaning one of them, which was 30 feet long, 20 feet wide, and 6 feet deep. The gas was supposed to have been drawn off, and ordinary air passed through the box with a view to clearing out as much of the impurities as possible. While Blackman was working at the bottom of the box, an explosion occurred, and he was badly burnt about the face and arms. It was contended on his behalf that the defendants or their servants were guilty of negligence in consequence of the impurities not having been drawn from the purifier before the men were sent to work in it, and also that the pipes were not properly sealed so as to prevent leakage of the gas. The plaintiff bore out his Counsel's opening statement. He added that his wages, while in the employ of the Company, averaged 25s. a week. He was taken to St. Mary's Hospital, Paddington, where he was detained until the 15th of November. He had been unable to do any work since, and still suffered from the shock. Mr. A. C. M'Minn, Assoc.M.Inst.C.E., the Resident Engineer at the works, stated that the process of cleaning the purifiers by forcing air through them had been approved by the Metropolitan Gas Referees; and it was only after the air had been pumped through for an hour that the cover was taken off in order that the men might enter. He acknowledged that a slight leakage had been found; but it was of no importance. The whole of the mains and the valves were new in 1879, and the purifiers themselves were new in 1883. Alfred Wells, the deputy-foreman in the purifying department, said he was present when the accident occurred, but could not account for it. His Honour remarked that it seemed to him like a miracle. Mr. Neilson said his suggestion was that it was a strange combination of causes, for which no explanation could be given. Witness went on to state that at the time of the accident the valves of the purifier were perfectly sound. The Jury found: (1) That there was defect in the works, or in the use of the works, which arose from negligence on the part of the defendants or of persons entrusted by them with the supervision of the works; (2) that this defect had not been discovered or remedied owing to such negligence; and (3) that it was in consequence of the defect that the accident occurred. This was a verdict for the plaintiff, in whose favour the Jury assessed the damages at £50. His Honour gave judgment accordingly, and allowed costs.

Sequel to the Accident at the Stoke Gas-Works.

At the Stoke County Court, his Honour Judge Mulholland, Q.C., recently had before him the matter of an arbitration between William Lamb, a bricklayer and retort setter, and Messrs. R. Dempster and Sons, Limited, of Elland; and he arranged an order for £1 a week compensation, deducting the total amount paid to him since the date of his accident. Applicant sustained a compound fracture of the right arm, a bruised back and hip-bone, and a scalp wound while employed by the respondents on the 10th of January last at the Corporation gas-works, Stoke; the accident being due, as reported in the "JOURNAL" at the time, to the principals supporting the roof of the building falling down. With reference to the fracture of the arm, part of the bone had had to be taken out, and consequently the arm was useless, rendering applicant totally incapable of following his trade.

Responsibility for Giving Notice to Discontinue a Supply of Gas.

At Marylebone Police Court on the 11th inst., Mr. Plowden had before him a case in which the Gaslight and Coke Company sued Mr. Healing for a sum of about £20 for gas supplied. Defendant carried on business in Pinduck Mews, Marylebone, as a cab and carriage builder, in 1891, and entered into a contract to use the Company's gas. He converted his business into a limited liability Company, and a contract was entered into by them to pay for the gas. In 1892 the Company failed, and the defendant again signed a contract for the supply of gas. A fresh Company was formed at the end of 1892, and the defendant was appointed Manager. From about that time until 1899 the accounts for gas were paid by the Company's cheques; but in this year the debenture-holders obtained an order to appoint a receiver and manager. The question now arose as to whether, owing to there not being sufficient notice in writing by the defendant, he or these parties were liable for the gas consumed. It was contended for the defendant that, as the Gas Company had received cheques of the limited Company for a number of year, there was sufficient notice of the defendant's intention to discontinue the use of gas, and that therefore the limited Company were liable. Mr. G. Merry, one of the Gas Company's collectors, proved the contracts signed, and said he had not received any written notice to stop the supply of gas. He also mentioned that the accounts were usually paid at the Company's chief office towards the end of the quarter, under pressure. Defendant was called to speak as to certain conversations which had taken place, and formally prove some documents relating to the formation of the Company. His Worship, after going through the evidence, said that his judgment must be for the plaintiffs, and with costs, as they were entitled to stand upon their strict right because of the failure of the defendant to give proper notice in writing as was required.

A Gas Company Fined for Polluting a Stream.

The Guildford Borough Magistrates recently had before them a summons taken out by the Conservators of the Thames against the Guildford Gas Company for having polluted the River Wey on the 22nd of October. It was stated by the representative of the Conservators (Mr. W. S. Bunting) that so long ago as 1897 the Conservators were in communication with the Company on the subject of the pollution then going on; and the following year proceedings were commenced with the view of stopping it. An undertaking was given that certain works should be carried out, which it was quite believed by all parties would put an end to the nuisance complained of; and consequently only a small penalty was imposed. The promised works were duly executed, and the trouble ceased. In the course of the present year, the Conservators had been again in communication with the Company on the subject; and they explained that the pollution arose in consequence of the very heavy rains having broken down a portion of their embankment. They undertook to carry out some repairs—in fact, they had started them before the complaint was made—and this pollution was stopped. The Conservators, however, in July, served a notice on the Company, calling upon them to obviate all sources of pollution. On the 22nd of October a sample of the effluent was taken, and it proved to be so bad that the Conservators had no alternative but to again institute proceedings. Assuming that there was something wrong, the Company opened up the works they had carried out two years previously, and discovered that, owing to the character of the ground, the pipes had sunk and caused a break, through

which the gas liquor found its way and caused the pollution. The Company had had this remedied; and since then there had been no pollution. Mr. Sparkes, who appeared for the Company, said he entirely endorsed what Mr. Bunting had stated, and would leave the matter in the hands of the Bench. The Company intended to exercise every precaution, as they had done in the past, to guard against a recurrence of the pollution. They took samples almost daily, and they did not at all anticipate that there would be any pollution in the future. The Mayor, Mr. G. Tayler, said the Bench understood that in this case the pollution was quite accidental, and arose from a matter of which the Company were not aware. Under these circumstances, although there had been a complaint before, they thought it would be sufficient if they inflicted a fine of £1, with £5 18s. costs.

Question as to the Appointment of an Umpire in the Ossett Gas-Works Arbitration.

In the Chancery Division of the High Court of Justice last Thursday, Mr. Justice Cozens-Hardy had before him a motion on behalf of the Ossett Gas Company, for an injunction to restrain the Mayor and Corporation of Ossett from summoning a jury for the purpose of determining the value of the Company's undertaking, which the Corporation were seeking to purchase. Mr. Vernon Smith, Q.C. (Mr. Beaumont with him), who made the application, said the short point to be decided was whether or not the Corporation were right in the view that the value to be paid by them to the Company could be ascertained by a jury. The plaintiffs contended that it could only be done by arbitration under the Lands Clauses Act. The Company was an old-established one; but on the 10th of July last an Act was passed authorizing the purchase of the undertaking by the Corporation. It was provided by section 5 that the Company should sell and the Corporation purchase the concern for such price and on such terms as should be agreed, or as, failing agreement, "shall be determined by arbitration, in accordance with the provisions of the Lands Clauses Act with reference to the purchase of land otherwise than by agreement." It also went on to provide that the Corporation should pay compensation to the Manager and Secretary of the Company, to be determined, in default of agreement, by arbitration. The Lands Clauses Act was not incorporated; the only reference to it being in the section named. On the 10th of August a notice to treat was given by the Corporation; and on the 27th, the Company gave notice of a request to concur in the appointment of a single arbitrator, or, failing this, to nominate an arbitrator to act on their behalf. On the 3rd of September, the Corporation appointed Mr. Monkhouse as their Arbitrator; and on the 6th, the Company nominated Mr. Corbet Woodall as theirs. A long correspondence (partly conducted by Mr. Henry Woodall, in his father's absence abroad) ensued between these gentlemen as to the selection of an umpire. In this correspondence, Mr. Monkhouse was pressing for the concurrence of Mr. Woodall in the appointment of certain gentlemen named by him, to which Mr. Woodall did not agree; and he, on his part, was pressing for an extension of time, which the defendants declined to agree to until the umpire had been appointed. Ultimately, on the 6th inst., when the three months limited by the Act had expired, the Company applied to the Board of Trade to nominate an umpire. But they had not yet notified whether or not they were prepared to do so; and on the 15th the defendants served the plaintiffs with notice of their intention to summon a jury. On this notice the motion was launched. He submitted that the defendants had no power to do as they proposed, and pointed out how inconvenient it would be for a jury to attempt to assess the value of such an undertaking as that of the plaintiffs, which the defendants themselves had estimated at £86,500. He also pointed out that if there was any difficulty about appointing an umpire, in consequence of the time having expired, the Arbitration Act of 1889 gave power to the Court to extend the time and make the appointment. Mr. Blennerhassett, Q.C., for the defendants, contended that whatever inconvenience might arise would have been caused by the plaintiffs themselves, and that under the Lands Clauses Act, when a matter was referred to arbitration, and the time was allowed to expire without any award being made, it was within the right of either party to summon a jury. Dr. Davies Williams, who was on the same side, further urged that, in any case, the plaintiffs were not entitled to an injunction, because, on their own contention, the inquiry before the jury would be futile and ineffective, and it was not the practice of the Court to interfere by injunction to prevent people making fools of themselves if they pleased, so long as, by so doing, they did not injure other people. Mr. Vernon Smith had commenced his reply, when Mr. Blennerhassett said he believed all trouble would be saved, as the parties were willing to agree to Mr. Punchard being appointed umpire. It was arranged that this should be done, and that the time for making the award should be extended to the 31st prox There only remained the question of the costs of the motion; and his Lordship, in a short judgment, gave his reasons for holding that the defendants were wrong in the construction they put upon the 5th section of the Act, and must therefore pay the costs.

The Felixstowe Gas Company Fined for Defective Illuminating Power.

At the Woodbridge Petty Sessions last Thursday, a summons was heard against the Felixstowe Gas Company, Limited, for having, on Nov. 22, supplied gas to the District Council of Felixstowe and Walton, of less illuminating power than provided by the Gas-Works Clauses Act, 1871. Mr. F. B. Jennings (Clerk to the Council) said the Company were incorporated under an Order of 1895, which provided that the minimum illuminating power should be equal to 15 candles. On Nov. 22, however, Mr. E. C. Sayer, the Gas Examiner, tested the gas, and found the mean lighting power was 14·5 candles. This certificate was forwarded to the Company; and on Nov. 24 the Secretary wrote acknowledging its receipt. Nothing more was heard until Dec. 5, when the Council received a letter, stating that the cause of the deficiency on the day named was an unavoidable accident—one of the retorts having broken down. The Secretary further called attention to the fact that in previous tests the illuminating power had ranged from 15 to 18 candles, with no impurities. The Order provided that no penalty should be incurred by the undertakers in respect of defect of illuminating power if it was proved that it was produced by an unavoidable cause or accident. Mr. Jennings contended that the defence now set up was an after-thought, and was no answer to the Council's allegations. Mr. A. J. Haward, for the Company, did not impugn the correctness of Mr. Sayer's certificate; but he did contend that the insufficiency of illuminating power was caused by an unavoidable accident, over which the Company had no control. They were, on Nov. 22, working with nineteen retorts; and one of them, through some unexplainable reason, collapsed. The retorts were charged every six hours. In the present instance, they were charged at ten in the morning, so it was not until four in the afternoon that the retort was discovered to possess a large hole. In consequence of this, the retort had drawn in a certain amount of air, which, on mixing with the gas, caused a reduction of the illuminating power. Everything possible was done to overcome the difficulty; and by seven in the evening, the gas had assumed its normal condition. Mr. William V. Watson, the Secretary and Manager of the Company, gave evidence, and in reply to the Bench, said the retorts were examined daily; and if one was found faulty, a report was immediately made. In cross-examination, witness added that each retort produced about 2800 or 3000 cubic feet of gas per 24 hours. The Company possessed two gasholders; and on the occasion in question, the smaller of the two, with a capacity of about 17,000 cubic feet, was at work. He believed it was nearly full. At that time they were consuming as much gas as they could possibly make. Mr. J. Watson, foreman, stated that at about seven or eight p.m. the gas was of 17 or 18 candle power. The holder was not full in the morning; it contained, he should say, at the least, 10,000 feet. Mr. Sayer was then called for the prosecution; and he stated that he was not informed, when he made his examination, that there had been a breakdown at the works. If the Manager had told him that a retort had collapsed, he would certainly have made a note of it on his certificate. Dr. Samuel Rideal expressed the opinion that the Company were to blame in the matter. It had been shown that the amount of gas consumed between ten a.m. and four p.m. was about 11,000 cubic feet—a quantity which, he pointed out, corresponded with the amount estimated to have been in the holder in the morning. He, therefore, held that the gas tested at the Company's office between five and six o'clock was manufactured before the breakdown of the retort had occurred. He was certain that the gas was manufactured in the state shown by the Inspector's examination, and was not due to the breakdown of the retort. Even assuming that the leakage in the retort did affect the quality of the gas, he considered the accident was one that might have been avoided, with due care. The Bench imposed a fine of £2, with costs £4 4s. 6d.

Embezzlement by a Collector.

At the Westminster Police Court last Wednesday, William George Straffon, a young man who had been in the service of the Gaslight and Coke Company as an automatic meter collector, was, on remand, charged before Mr. Horace Smith with embezzling the moneys of the Company. Mr. R. H. Humphreys prosecuted, and Mr. P. Conway appeared for the prisoner. The excuse made by Straffon for not paying in some £12 collected from gas consumers was that the money had dropped through a hole in his pocket. It appeared that he had falsified his account-book, and had given customers wrongly dated receipts. Mr. Conway said the accused deeply regretted that he had tried to deceive the Court, and he now made the only reparation in his power by telling the truth. He had not lost the money from his pocket, but he had foolishly spent it. A clergyman who had known the accused for seven years said that up till this time he had borne an irreproachable character, and had been associated with Church work. Mr. Horace Smith: Persons who embezzle are generally those who are presumed to be of good character. They get situations of trust because of this. Here is a young man who has carried out his defalcations with much forethought, skill, and premeditation. Then he falsifies his accounts and persists in a fabrication about losing the money from his pocket until the story is disproved by evidence. After that he appeals for consideration on the ground of character. He must have three months' hard labour.

Water-Gas Plant at Chorley.—The formal inauguration of the installation of water-gas plant which Messrs. Humphreys and Glasgow have put up at the Chorley Gas-Works, at a cost of about £5000, took place on the 13th inst.

Aldershot Gas and Water Works Purchase Question.—A meeting of the ratepayers of Aldershot, convened by the Chairman of the District Council (Mr. J. May), in his private capacity, in response to a memorial presented to him, was held a few days ago to consider the advisability of the purchase of the undertaking of the Aldershot Gas and Water Company. Mr. C. Calvert, who has taken the initiative in the matter, and has laboured very earnestly to attain his object, submitted a motion to the effect that the undertaking should be bought and worked by, and on behalf of, the town. He said he estimated that it could be acquired on the basis of 25 years' purchase of the net earnings *plus* 10 per cent. for compulsory sale, which came to £245,000. Adding £10,000 for parliamentary expenses, he reached a total of £255,000. To repay this sum in 50 years would require £9610 annually. The Company's profits came to £9000, and the Directors' fees to £1000—together, £10,000—which would leave the ratepayers a profit of £200 or £300. The proposal was not very cordially received by the ratepayers, one of whom suggested that its further consideration should be adjourned for a month; while another expressed his willingness to support the suggestion, if the period were extended to six months. Mr. Calvert thought they ought to "fight it out" then and there. The "fighting" accordingly commenced, and the proceedings at times became boisterous. An opinion seemed to prevail that the undertaking should be left in the present hands. At all events, more time was needed for consideration. Mr. Huntley moved, as an amendment, that the meeting stand adjourned for three months. Mr. Watts seconded the amendment; but nothing came of it. In the end, Mr. Calvert's motion was carried by 43 votes to 33. Of course, this vote does not pledge the ratepayers in any way. If the Council decide to go on, a statutory meeting of the inhabitants will have to be called to authorize the step.

CORRESPONDENCE.

[*We are not responsible for the opinions expressed by correspondents.*]

Mr. Dibdin's Chemical Industry Society Paper.

SIR,—There are some figures in Mr. Dibdin's interesting paper, given in your issue of the 11th inst., which seem to require elucidation.

In Tables I., III., and V., giving the tests respectively of Widnes, Gaslight and Coke, and South Metropolitan gases, with the various burners, as stated, I note that with 13·5-candle power gases, Mr. Dibdin found that a No. 4. Sugg table-top burner required 9·4 cubic feet of Gaslight and Coke Company's gas to give the same result as 7·7 cubic feet *of the same illuminating power gas* at Widnes; the No. 5 burner requiring only 6·2 cubic feet of the latter gas, and 8 cubic feet of the Gaslight and Coke Company's, while the Welsbach "C" burner required 4 cubic feet of the former, and only 2·9 cubic feet of the latter. Again, under "14·5 illuminating power," we have 9 cubic feet of Gaslight and Coke Company's gas required, but only 5·9 feet of the same illuminating power gas of the South Metropolitan Company; while Bray's fishtail No. 4 required 10·1 cubic feet of the former, and only 5·3 feet of the latter. The No. 5 Bray, again, only required 5·9 cubic feet of South Metropolitan gas, but 10·3 feet of the Gaslight and Coke Company's.

It will thus be seen that the difference in the results with the same illuminating power gases, as shown in the tables, vary as much as 90 per cent.—*i.e.*, Bray's fishtail No. 4, South Metropolitan 14·5-candle gas 5·3 cubic feet, and Gaslight and Coke 14·5-candle gas 10·1 cubic feet. I also note that Widnes gas shows 4·9 cubic feet of 16·2-candle power gas "*to produce the normal intensity of 16 candles*," but 5 feet of 17·2-candle gas to produce the same result.

Perhaps Mr. Dibdin can explain why 90 per cent. more of *the same illuminating power gas* is necessary on the north side of the Thames than on the south of the river, to give the same "normal intensity," from the same burner. To an ordinary reader, these discrepancies are somewhat startling, more especially coming from a gentleman with the recognized scientific attainments of Mr. Dibdin.

D. T. LIVESEY.

East Grinstead, Dec. 19, 1900.

Retort Ascension-Pipes.

SIR,—Mr. Harman, in last week's "JOURNAL," raised the question, Why use two ascension-pipes for horizontal retorts, when one pipe only is required for the inclined retort?

For several months now, I have had three centre retorts (those immediately over the combustion-chamber) working with one 8-inch pipe; and so satisfactory has been the working of these pipes, that I have decided to adopt the one 8-inch pipe instead of the usual two 6-inch ones on all the new work I am erecting here next year. The advantages to be gained, so far as my experiments show, are as follows.

A considerable reduction in the temperature of the gas entering the hydraulic main. I do not suppose this would have been so, if equal volumes of gas would pass up the two 6-inch ascension-pipes during the charge. But from a number of temperatures I have taken from time to time, I have never found this to be so. With one ascension-pipe, there is no doubt which way the gas is going.

The reduction of temperature in the pipe should to a great extent do away with the nuisance of stopped pipes, especially where the hydraulic main is used and high heats worked.

The adoption of one 8-inch pipe will simplify, and save cost in, construction, reduce by one-half the number of pipes for the men to keep clear, and where machinery is used the men would get through the work quicker.

From the experience I have had with the working of these pipes, my own opinion is that two ascension-pipes are not required.

HY. SIMMONDS.

Bury, Dec. 20, 1900.

SIR,—I notice in the last issue of the "JOURNAL" a letter from Mr. Edward A. Harman, on the above subject. His reasoning and facts are no doubt quite correct, but were, however, fully known to the generality of gas engineers—particularly to those who have had experience with inclined retorts and stoking machinery with 20-feet through retorts. It hardly remains "for someone to be bold enough to arrange horizontal retorts 20 feet long fitted with a large ascension-pipe at one end only," because, as is pretty well known, this was done many years ago at the Nine Elms works; the sufficiently "bold" man being the late Mr. John Methven. As Mr. C. C. Carpenter recently mentioned, Mr. Methven's "make and quantity of gas per ton were among the highest in his Company."

MERLE BLANC.

Dec. 20, 1900.

Port Erin and Port St. Mary Gas Company.—The Chairman of this Company at the annual meeting last Tuesday was able to congratulate the shareholders that, in the second year of working, they had earned a dividend of 2½ per cent. He also announced that the consumption of gas had increased threefold during the year.

Smethwick to Oppose the Mond Scheme.—There is a strong agitation in Smethwick against the proposal of the promoters of the Mond gas scheme to erect their works there. At the meeting of the Town Council last Tuesday, the Town Clerk explained that it was intended to purchase 30 acres of land near Brasshouse Lane, at present occupied as allotments. He understood that the Mond gas would be supplied for all purposes except illumination; the charge to be 6d. per 1000 cubic feet. Mr. Stones (Chairman of the Gas Committee) said the Council had a monopoly at the present time; and it would be unfair, after spending such a large sum of money in mains for the supply of engines, to allow the Mond Company to come in. Mr. Pinkney said this was no wild goose scheme, and the only way they could keep the Company out was to manufacture cheap gas themselves. The Town Clerk was instructed to take the necessary steps to oppose the Bill.

MISCELLANEOUS NEWS.

MANCHESTER CORPORATION GAS SUPPLY.

Alderman Gibson and the Gas Profits—Discussion Adjourned.

At the Meeting of the Manchester City Council last Wednesday, Mr. Alderman R. Gibson, Chairman of the Gas Committee, and ex-Lord Mayor, brought up his motion on the subject of gas profits, the consideration of which had been adjourned from previous meetings. His proposal was to the following effect: "That, in the opinion of this Council, the present system of subsidizing the rates out of the profits of the gas undertaking is wrong in principle, unjust in practice, inimical to the best interests of the ratepayers, and ought to be discontinued."

Alderman GIBSON, in moving the resolution, remarked that for some years he had held the opinion that it was wrong in principle to subsidize the rates out of the profits of the gas undertaking; and when, a few months ago, the Council took £40,000 out of the pockets of the gas consumers, openly and avowedly for the sole purpose of lessening the general rates, he felt that a great injustice was being done to a class of people whom it was his duty to protect, and that a blow was being aimed at the prosperity of an undertaking in which he was deeply interested, and for the success of which he should, in the main, be held responsible. In the first place, he wished to urge that it was wrong in principle to subsidize the rates out of the profits made on the gas. Why? The proper principle, as he took it, was to make every department of the Corporation responsible for its own acts and its own expenditure. Every tub should stand on its own bottom; and it was wrong to make any one portion of the community bear more than its fair share of the public burden. When they, in effect, said, as they had done, that £10,000 was not enough for them, that they wanted £50,000, and that if the Gas Department did not make this amount, they must charge the gas consumers 3d. per 1000 cubic feet more for their gas, he submitted that they were making the gas consumers bear more than their fair share of the public burden. They were taking a large sum of money out of their pockets, and putting it into those of people who did not burn gas at all. This policy was also unjust in practice. As he had previously pointed out, when 1d. per 1000 cubic feet was equal to 1d. in the pound on the rates, and all were gas consumers, although the principle was unsound, he took no exception; but now the case was quite different. There were upwards of 3000 ratepayers who had given up burning gas, and were using electricity for their lighting purposes. Besides this, there were in use 500 motors worked by electricity; and they had no right to put an extra tax upon the gas consumer and offer a premium to the electric light consumer. Taking the names of 21 large ratepayers, all of whom now used electricity, their total assessment was £66,855. Fourpence in the pound came to £1114; and this sum they were deliberately taking out of the pockets of the gas consumers—who, be it remembered, were ratepayers—and putting it into the pockets of large ratepayers who were not gas consumers, but who used electricity. This was both unfair and unjust. But it might be said that they were relieving the ratepayers. Indeed! He had taken the cases of a number of small shopkeepers—men who began to burn gas early in the day, and kept on burning it until ten or eleven o'clock at night, and who had in many instances a hard struggle for existence. How had these people been relieved? Their total assessment was £830; and 4d. in the pound on their rates came to £13 16s. 8d. They therefore had their rates relieved to the extent of £13 16s. 8d.; but by having 3d. per 1000 cubic feet put on the price of their gas, they had to pay £26 15s. more for it than they used to do. They would consequently have been £13 better off if they had been left to pay the increased rate, and allowed to have gas at the old price. These were only 30 out of 102,000 gas consumers. Again, he had taken twenty ratepayers who used gas-engines—20 out of some 1600. These were assessed at £777 a year. Now 4d. in the pound on this sum was equal to £12 19s. Their total gas-rental was £383, 3d. per 1000 cubic feet on which was £42 11s. So that while they were relieving the rates of these people by £12 19s., they were actually getting £42 11s. out of the same people's pockets wherewith to do it. Take one other instance. There were 45,000 gas consumers in Manchester having 2 and 3 light meters. Reckoning the gas they consumed as 20s. worth a year each—which was certainly far less than they did burn—this would mean 8000 cubic feet each. Therefore 3d. per 1000 cubic feet would mean that they had to pay 2s. each more for their gas, which for the total number would come to a net sum of £4500. What became of this £4500 which they were taking out of the pockets of their very poorest consumers and ratepayers? They were putting it into the hands of their landlords, who did not burn any gas. Even these cases, however, were few in comparison with the large number of ratepayers whom they compelled to pay more than they should do, under the delusion that they were benefiting the ratepayers. They might relieve the rates, but they were not relieving the ratepayers, of whom there were 120,000 on the register; and in the city, excluding the out-townships, there were 102,000 gas consumers. If they liked, he would give them 22,000 of these consumers who might benefit by having 4d. in the pound taken off their rates. What about the remaining 80,000? Were they legislating for the benefit of the many or of the few? If for the many, then he said without hesitation that, under the idea of relieving, they were actually penalizing the great bulk of the ratepayers to the extent of 10s. for every 5s. they took off their rates. Taking his own case, his rates were relieved to the extent of £1 13s., but he was charged £5 12s. more for gas; and no doubt this was fairly typical of the whole 80,000 ratepayers who were gas consumers, and who were penalized to relieve the rates of the remaining 22,000, many of whom were users of electricity. The policy which had been pursued had been inimical to the best interests of the ratepayers. The Corporation had had the gas-works under their entire control for 57 years, during which time they had made a gross profit of £5,345,194. What had they done with it? Well, for ten years they handed over a moiety of it each year to the Water Committee, to relieve the Committee from the necessity of raising the price of water. This was a perfectly legitimate and proper thing to do; it really relieved the ratepayers. The £166,000 which they gave out of the gas profits relieved every ratepayer in the city without distinction. They had, however, given away

out of gas profits ten times this sum, which had not benefited a single citizen, but had been an injury to all. They had paid £1,058,616 for interest on borrowed money which there had been no necessity to borrow. In June, 1843, when they took over the gas undertaking, the mortgage debt was £83,750. From this time to June, 1845, they made a profit of £83,233; so that during this period they could have paid off the whole of the mortgage debt and left the works free. Between 1843 and 1850 the capital expenditure was £83,376, and the profit £297,136, or £200,000 more than they had spent. Consequently, if the Gas Committee had used the profits for the extension of their own works, as the conductors of any private concern would have done, they would at all events not have had any necessity to borrow money during the seven years. From 1850 to 1860 they spent on the works £289,668; but they made a profit of £553,614—nearly twice as much. From 1860 to 1870 they spent £399,773, and made a profit of £672,377. From 1870 to 1880 they spent £687,540, and made a profit of £1,172,256. Yet they borrowed money. From 1880 to 1890 they spent on the works £562,863, and made a profit of £1,462,519. From 1890 to 1900, they spent on the works £803,904, and made a profit of £1,187,292. And yet, with all this excess of profit over expenditure, they still went on borrowing money. He thought these figures fully justified him in saying that the £1,058,616 which had been taken out of the pockets of the gas consumers to pay interest for borrowed money need never have been taken; and no one was the better off for it except those who lent the money, who were not Manchester people at all, while the citizens were distinctly worse off by this amount. The principle of using their own profits for the development of their business was much broader and wider and more far reaching than he had time to indicate; and he should be glad to hear any reason why a municipal undertaking should be carried on by other than well understood and well recognized sound commercial principles. He honestly believed that if the Gas Committee could have utilized their profits during the whole of the last fifty years, gas could have been sold at 6d. per 1000 cubic feet less than it had been, the whole of the works (probably of much greater magnitude than they were now) rendered free from debt, and the citizens of Manchester made £2,085,072 better off than they were to-day. They would not have owed £1,026,456 on the works as they now did, and would not have had to pay £1,058,616 in interest on borrowed capital. They had always made nearly twice as much profit as they could possibly spend in plant to feed their increasing business; and he therefore held that it was altogether unsound policy to borrow money. He believed that, if they were now to begin *de novo*, they could enrich the citizens of Manchester by £50,000 a year, and not require to raise another penny for their gas undertaking, and so save the necessity of taking any more money out of the pockets of the gas consumers, who were ratepayers, to pay for interest on borrowed money. Having thus explained his main reasons for moving the resolution, he would only briefly allude to what might be called the side-issues of the question, although they were of great importance to a large community. Who could tell what cheap light and cheap gas meant to the citizens of a large city? When they reduced the price 3d. per 1000 cubic feet, the number of gas-cookers on hire increased in four years from 3781 to 9560, and the gas-engines from 932 to 1662. Besides giving encouragement to small manufacturers, and creating a demand for labour, did they not think it also had something to do with purifying the atmosphere? Not only did cheap gas mean an increasing use of small engines, but he did not see why they should not have gas-engines of 100, 500, or even 1000 horse power, in this country, as he believed they had in some places on the Continent. Cheap gas meant large manufacturers doing away with their steam-boilers, saving the dirt and trouble of getting in their coal, and the worse dirt and greater turmoil of getting rid of their ashes, and preventing their black smoke polluting the atmosphere, with consequent fines and costs. Besides all this, he felt that the Gas Committee should not rest satisfied until a gas-stove was in every office in the city, and a gas-fire and a gas-cooker in every house. Then indeed they would have greater cleanliness, less work, better cooking, and more comfort all round. Smoky chimneys would become a thing of the past, and Manchester would be brighter and healthier. In conclusion, he might say that he did not expect to carry the resolution by what could be called a large majority, nor, perhaps, could he hope to uproot an old custom and long-standing prejudices by one stroke of the axe; but he fully believed that the considerations he had urged would, sooner or later, permeate into the minds of the ratepayers and gas consumers themselves, and become impressed upon the consciences of the great majority of the members of the Council.

Mr. LAMBERT formally seconded the motion, and observed that, after trying to bring it forward at several meetings, Alderman Gibson had at last succeeded in putting before the Council his views on the matter. They could scarcely hope to discuss it at any length that afternoon; but he was quite sure, from a perusal of some of Alderman Gibson's notes which he had had the opportunity of making, that the figures he had given and some of the statements he had made were really deserving of serious consideration. His statistics put the matter in a very different light from what some of the Council had expected. He (Mr. Lambert) would therefore suggest that the discussion of the question might be adjourned, and that, meantime, Alderman Gibson should be asked to send a copy of his notes to members of the Council, so that they might have the figures before them to enable them to come to a decision.

Alderman GIBSON agreed with Mr. Lambert's suggestion, and said he should be glad to send copies of his notes to the members.

Mr. PLUMMER remarked that, if the matter were taken then, he was quite prepared to traverse some of the arguments which had been adduced, and try to convince the Council that the view Alderman Gibson had taken was erroneous. But he thought it best to adjourn the discussion.

Sir JOHN HARWOOD said that, if Alderman Gibson sent out his notes, he thought he ought to correct one statement. By Act of Parliament they were not permitted to spend the gas profits on the extension of the old works and the construction of new ones. They were obliged to go to Parliament for powers and borrow money.

Eventually the proposal to adjourn the discussion was agreed to; Alderman Gibson promising to supply copies of his notes to members of the Council.

The late Mr. John Blacket Gill, Chairman of the Commercial Gas Company, left personal estate of the value of £37,255.

THE SINGAPORE MUNICIPALITY AND THE GAS-WORKS.

The Purchase Decided Upon.

The "Singapore Free Press" for the 20th ult., a copy of which has just reached us, contains a report of the proceedings at a special meeting of the Municipal Commission, held on the previous day, at which the report of Mr. Corbet Woodall on the question of the acquisition of the undertaking of the Singapore Gas Company, to which reference has already been made in the "JOURNAL," was considered. The subject was introduced by Mr. Gentle, who stated that Mr. Woodall, in the report before the members, dealt frankly with the causes which had been felt for many years of the non-popularity and ill-success of the Gas Company in providing for the gas supply of the town. It was the old story of monopoly; but the Company had had a formidable competitor in the free introduction of petroleum, the consequence of which had been that petroleum was being used in almost all private houses. With regard to Mr. Woodall's reference to the introduction of penny-in-the-slot meters, he considered this would be a very good thing; but it was too early to say whether the system would take root in Singapore. Certainly these meters would save a good deal of time in collecting accounts. He (Mr. Gentle) had received documents showing that the monthly charge at St. Andrew's Cathedral, since it had been lit with Welsbach burners, had dropped from $23·43 in 1898, for a place of darkness, to $7·92 at the present time, for a place ablaze with light. Another matter to be considered was the position the Commissioners would occupy with regard to the ratepayers, if Mr. Woodall's report were adopted, and it was decided to acquire the gas-works and to provide for the public lighting in the future. By an amendment of the Municipal Ordinance, the Commissioners were allowed to spend municipal funds on private lighting; but the question was whether they should take their chance of collecting the money due to them by consumers, or whether they should apply to the Legislature for special powers such as those possessed with regard to a private water supply, under which they would be able to collect the money in the same way as the rates and taxes, and if people did not pay they would be sued. If it was decided to acquire the property, the Commissioners would have to borrow $500,000, which would thus reduce their borrowing powers by this sum; but he did not think this would be a very material drawback, though, of course, they might have other works to execute in the future. They now had to consider whether those of the Gas Company should be bought, and at the price of £41,200 put upon them by Mr. Woodall, or propose any other course that might be deemed expedient. In conclusion, he suggested that, in the event of the works being acquired, a loan of possibly $1,000,000 should be obtained, as it would prove more attractive to investors than two or three small loans.

Mr. Gentle was followed by Mr. Jago, who confessed that, before it became his duty, as a Commissioner, to study the question of the lighting of Singapore, he had loosely formed two main ideas on the subject—first, that the only suitable light was the electric light; and, secondly, that the works and mains of the Gas Company were worth just their value as scrap iron, and no more. There were many persons in Singapore who held similar opinions—in fact, the great majority seemed to be of that way of thinking. But, as he studied the subject, he was compelled to abandon both of these theories; and the report of Mr. Woodall, supplemented by the information he had obtained, completed his conversion. Having started with a strong predilection for electric light, he had gradually worked round, until he was of opinion that gas was the only lighting suitable for Singapore. There were but two systems of illumination worth their consideration—acetylene and oil being out of the question—and these were electricity and gas. When the Commission consulted electrical experts, there was some idea that 32-candle glow lamps would do for the less important streets, while the principal thoroughfares should be lighted by arc lamps. They duly received an estimate of the first cost of an installation to supply 80 arc lamps and 800 32-candle power glow lamps, besides 20,000 8 candle lamps for private lighting, which amounted to £104,000 if low-speed engines were used, and £109,000 if they used high-speed ones. But, in the opinion of the best authorities, a 32-candle glow lamp was not nearly so efficient for street lighting as a 35-candle Welsbach, on account of the light not being so diffused. This left the arc lamp as the only rival of gas for public lighting; and it did not need any argument to prove that it would be the height of absurdity to replace all their lamps by arc lights at a fabulous cost for maintenance. The experts proposed that the 20,000 8-candle lamps for private consumers should be supplied with current at the rate of 1s. per Board of Trade unit, or just double the usual charge in England. They stated, however, that, as compared with Welsbach burners, taken at $4 per 1000 cubic feet (also double the average price in England), the electric light would cost 5½ times as much as gas for the same candle power. The proposed installation made no provision for increasing the number of street-lamps; and seeing that there was no prospect of private consumers taking current at so high a cost as compared with gas, he thought most people would agree with him in thinking the scheme quite beyond the means of Singapore. He did not urge that electricity should not be tried; but, as Mr. Woodall had said in his report, the easiest way to bring electric light within their reach was to own the gas-works. It was easy to understand how people whose experience of gas lighting was confined to Singapore, or who had not particularly observed the lighting in Europe, had come to look upon gas as an effete and dying light. But it was far from being so. Mr. Woodall had told them that in his opinion, Berlin was the best-lighted city in Europe; and very few electric lights were used in the streets there, but the gas-lamps were placed close together, and were of the newest style. Glasgow was usually considered one of the most up-to-date cities in Great Britain, and the Corporation were laying scores of miles of electric tramways; but, notwithstanding this, the use of gas for street lighting was to be increased. These facts showed that other towns did not regard gas as "the light that failed." There seemed to him to be little doubt that the limit of improvement in incandescent lighting was not yet in sight, and they might see, in the future, changes as startling as those which had taken place during the past twenty years. There was no doubt that, for street lighting in Singapore, gas would be much better and cheaper than electricity; and, at the same time, gas was much more likely to be extensively used in shops and private houses than the more costly electric light. In this belief, he

was prepared to vote for the purchase of the Gas Company's works. He had no doubt that, if they considerably reduced the price of gas to private consumers, and continued that policy year by year, as they cheapened their cost of production, they could, in a few years, more than double the present private consumption. It might be a departure from municipal methods, but he was inclined to favour their obtaining a good gas engineer —preferably a young man—at a low salary, and giving him a commission upon every 1000 cubic feet of gas by which he increased the private consumption. There was little doubt that the gas supply could be made a great commercial success, if they put good business men on their Lighting Committee.

The next speaker was Mr. Maclaren, who said that personally he was prepared to vote for the purchase of the works, though he was not altogether satisfied with the price mentioned by Mr. Woodall. Their Engineer, in his report of last year, estimated the cost of new works (to produce 40 million cubic feet of gas per annum) at £50,000; but this estimate would have to be increased somewhat now, owing to the rise in the price of land, &c. He further told them in 1899 that the Gas Company would be very ill advised to refuse an offer of £35,000; and he added that the situation would not be unfavourable to the Commissioners if the Company refused such an offer. On the strength of these figures, he (Mr. Maclaren) must say he was surprised at the comparatively high figure put by Mr. Woodall as the value of the gas-works; and he could not help thinking that he had shown a bias, though a slight one, in favour of the Company, and had not taken into the fullest consideration the great advantages the Municipality possessed in treating with the Company. He (the speaker) was glad to be in perfect accord with Mr. Woodall in the closing paragraphs of his report; and it was also his strong opinion that no scheme for the general lighting of Singapore could be complete which left electricity out of the question. There was no denying that gas was suitable for street lighting; but in the climate of Singapore, where coolness was almost everything in the houses, they ought to have electric light. He therefore thought that, if this scheme went through, a sum should be added to the capital which it was proposed to raise, in order to put up an electric installation to be worked with the power derived from their gas-mains.

Mr. Barker, who spoke next, said the resolution had his hearty support; and he expressed the hope that it would be carried unanimously. He felt quite certain that any amendment which purposed offering the Gas Company less than Mr. Woodall's valuation would not be accepted by them, and would only lead to a renewal of the protracted and wearisome negotiations which they trusted had now come to a final issue. He added a few words on the purchase from a commercial point of view. He said it must not be forgotten that in buying this concern they had not the unanimous support of the ratepayers. They were taking this step because, in their deliberate judgment, they believed, having regard to the financial position of the Gas Company, and the necessity on their part of taking a forward step in the lighting of the town, that they were acting in the best interests of the ratepayers and for the future welfare of Singapore. Their success would be their justification. They were for the first time embarking in a commercial undertaking, and they must be careful to avoid the mistakes of the existing Company. As to the public lighting, directly the transfer was effected, they should abolish every naked light in the town, and substitute Welsbach burners. Further, in the principal thoroughfares they should utilize all the available standards they had for doubling the lights, and arrange for as many more as would be required for the purpose. Gas would also have to be gradually extended to districts in the suburbs, now in darkness. But their main chance of profit would come by nursing the business with private consumers. In this direction there was scope for enormous developments. The re lighted streets would be an advertisement; but, in addition, he would light up, free of charge, for three months, a shop in every busy thoroughfare. It would awaken interest, and also be a capital advertisement. They should get a good stock of fittings suitable for shops and private houses, and make it worth the Manager's while to push the business with private consumers; fit up a show-room in the Municipal Offices, with a photometer, and have a capable person in charge to explain to callers the cost of any installation required, and show the relative merits of gas and oil; and replace the existing pipes in some streets where the pressure was worst, with cast-iron mains as recommended by Mr. Woodall. But, above all things, they should not be stingy with the public. They should abandon any idea of immediate profit, but should work for the future; and the business, if properly fostered, would surely come, and with the business their legitimate profit. By carefully working on business lines, they could justify the purchase to the public, vastly improve the lighting of the town, and save the ratepayers' money.

The following resolution was then put to the meeting, and carried, with two dissentients: "(1) That the Commissioners, having carefully considered the report of Mr. Corbet Woodall on the lighting of Singapore and on the proposed acquisition of the works of the Singapore Gas Company by the Corporation, are convinced that, under all the circumstances, it is desirable that these works should be acquired, at the price and on the conditions indicated by Mr. Woodall; and that, as the Gas Company have, by their resolution of the 26th of April last, agreed to sell at Mr. Woodall's valuation, application be made forthwith to the Governor in Council for sanction to the acquisition by the Corporation of the land, works, plant, mains, meters, tools, and all apparatus, fixed and loose, in Singapore belonging to the Gas Company, for the sum of £41,420 sterling, to be paid at the dollar rate for demand bills on London on the day of transfer—the stock and stores to be paid for in local currency at their value as assessed by valuators agreed upon between the parties; and that information to this effect be made to the Gas Company. (2) That application be further made to the Governor in Council, under section 271 of the Municipal Ordinance, for sanction to borrow a sum not exceeding $500,000 for the purposes of the above acquisition, and for the improvement of the gas apparatus and plant."

The ratepayers of Wallasey gave their consent yesterday week to the General Bill of the District Council, who desire authority, *inter alia*, to construct a railway to the gas-works from the line of the Mersey Docks and Harbour Board. Mr. James Wright, who presided, stated that it would give much needed facilities for dealing with the supplies for the gas-works.

THE CARBIDE OF CALCIUM AND ACETYLENE INDUSTRIES IN GERMANY.

(*Continued from p.* 1532.)

The history of artificial lighting shows that every new illuminant upon its introduction underwent a certain probationary period, during which many accidents occurred, until the experience necessary for its successful use had been obtained. Of the truth of this observation, petroleum, coal gas, and electricity give striking examples. There is no disputing the fact that at first a certain number of explosions were caused by acetylene, and that the accounts of the same—often unduly exaggerated—were instrumental in prejudicing the public and insurance companies against the new illuminant. In course of time, however, it was observed that only in a few cases had much damage been effected, and that cases in which loss of life had been caused were rare and comparatively not more numerous than those resulting daily from coal gas, benzene, petroleum, and other illuminants. Explosions from unknown causes, from the use of liquefied and compressed acetylene, and those produced by the experiments and manipulations of ignorant and unskilful persons, have not been taken into consideration, as they lie outside the scope of the present remarks.

The apparent great simplicity of the generation of acetylene from carbide by means of the simple chemical action of water, caused at the beginning a perfect mania of inventions for generators, lamps, and the various accessories of acetylene lighting. The Imperial Patent Office in Berlin has never before received so many applications for patents in one single class. A large number of these patented apparatus emanated from utterly inefficient persons—amateurs, tinsmiths, blacksmiths, &c.; and their manufacture, installation, and management were often carried out by the same incompetent persons, who were utterly wanting in the necessary scientific knowledge and practical experience. The result was that many explosions occurred, that the public became prejudiced against the new illuminant, and that the police authorities issued most stringent regulations for the installation and use of acetylene apparatus. During the last two years, this state of things has gradually and entirely changed. Insecure, unpractical, and badly finished apparatus has been gradually eliminated; the proportion of accidents has to a great extent ceased, while the police restrictions have been correspondingly relaxed; and the public are showing a daily increasing interest in the new illuminant. At the present time, if the necessary care is observed, there is no greater element of danger in the use of acetylene for lighting and other purposes than in the use of coal gas or petroleum. The most convincing proof of this assertion is that the German public and private fire insurance companies, whose interests are most vitally affected by acetylene, have decided, if certain simple precautions are taken, not to exact any additional premium on the rates for insurance of buildings lighted by acetylene.

The official organs of the German public fire insurance companies published, in the June issue of this year, statistics regarding explosions and fires caused by acetylene and other illuminants during 1899. In spite of the large number of acetylene installations in Germany, the explosions and fires attributed to acetylene are only six in number; and they were, with one exception, caused by culpable neglect of the most ordinary precautions, and would have occurred had any other inflammable gas—for instance, coal gas or water gas—been used in place of acetylene for lighting purposes. The damage done to property was of a trifling description, except in one instance, where it amounted to about £225. The explosion and fire in this case resulted from the thawing of frozen pipes. The number of fires caused during the same period by electricity was 85. It is becoming daily more apparent that electricity does not possess the immunity from fire with which it is generally credited. In estimating the value of the above statistics, it must be remembered that they are issued by the public fire insurance companies themselves, and are therefore not open to the suspicion of partiality.

In those cases where cheap water or other power is available, acetylene has not been able to compete seriously with electricity. In the absence of favourable conditions for the generation of electricity, it has made remarkable progress in Germany, in spite of the competition of coal gas, for the lighting of small towns and villages. The three principal determining factors for the adoption of coal gas or acetylene are at present: (1) The cost of installation. (2) The quality of the light. (3) The cost of daily production.

With regard to the first, there is little doubt that the initial expenditure for the installation of acetylene lighting is much lower than that for coal gas. As far as the writer has been able to ascertain, this consideration has played an important part in the deliberations of the municipal authorities of small towns concerning the adoption of acetylene. The following reasons for the lower cost of an acetylene installation, compared with a coal-gas installation, are generally urged: (1) The simplicity of the generation of acetylene—action of water upon carbide—compared with the distillation of gas from coal. The production of coal gas requires an extensive plant and several workmen; acetylene is produced from water and carbide in small generators in so simple a manner that a gas-works for a small town can be attended to by one workman. (2) The fewer impurities present in acetylene permit of a more simple method of purification. This is shown by a comparison of the acetylene purifiers with the apparatus necessary for the elimination of the impurities of coal gas. (3) The fact that the hourly consumption of gas from an acetylene gas-works is only about one-fourth that of coal gas for the same time and number of jets, which enables the condensers, purifiers, and gasholders to be built of much smaller dimensions. This is a fact of some importance, especially with regard to the gasholder, which need only possess a capacity of about 25 to 30 per cent. of the daily maximum consumption, because, in case of need, acetylene gas can be much more quickly generated.

A brief comparison is here given of the cost of electric, coal gas, acetylene, and petroleum lighting in Germany, with special reference to acetylene and coal gas. The price of carbide at the beginning of the year—about 32 pf. (4d.) per kilo. for small quantities—has been taken as a basis, although the price for larger quantities was about 28 pf.

(3½d.). Since then the prices of carbide have fallen; so that the present cost of acetylene is actually below the amount given hereunder.

One cubic metre of acetylene requires 3½ kilos. of carbide; adding another ½ kilo. for waste in feeding the generator, &c., and for leakage from piping, increases the total amount of carbide for 1 cubic metre to 3¾ kilos., at a cost of 1 m. 17 pf. The expenditure for the gas-works installation—piping, renewal of purifying material, interest on capital, attendance, wear and tear, &c.—amounts to about one-fourth of the total sum expended on carbide; in very rare cases, perhaps, to about one-third. This raises the price of 1 cubic metre of acetylene to 1 m. 50 pf. The following quantities of the different illuminants, according to Professor Vogel, give the same illuminating effect as 1 cubic metre of acetylene, and cost the amounts stated:—

	Currency. m. pf.	Sterling. s. d.
1 cubic metre of acetylene	1 50	1 6
6 litres of petroleum, at 25 pf. per litre	1 50	1 6
16 cubic metres of coal gas burnt in open burners	2 72	2 9
4 cubic metres coal gas burnt with incandescent mantle	0 68	0 8½
5 200-watt electric lights	3 45	3 5½

To the sum of 68 pf. for incandescent coal-gas light, about 10 per cent. ought to be added for mantles, glasses, and loss in illuminating power. The average for the price of coal gas in the above table (17 pf. per cubic metre) is taken from the following towns: Berlin, 16 pf.; Hamburg, 18 pf.; Breslau, 17·74 pf.; Darmstadt, 22 pf.; and Düsseldorf, 16 pf.

The table indicates that petroleum and acetylene are now about equal in price (the waste and incidental expenses of petroleum are greater, and its tendency is to rise in price, while acetylene tends to sink); that coal gas in an open burner is dearer than acetylene, but that incandescent coal gas is cheaper; and that electric lighting is more than twice as dear as acetylene. A few remarks are necessary with regard to the second point. Photometric measurements for the comparative determination of the illuminating power of the Welsbach mantle and acetylene are generally carried out in laboratories where the actual conditions are different from those of daily life. The light from the Welsbach mantle is measured horizontally; whereas in daily life the light falls, more or less, in a slanting direction upon the objects to be illumined, and thus loses considerably in candle power. The above figures do not lay claim to absolute accuracy, but endeavour to give an impartial idea of the present condition of affairs in the lighting industries.

The following list of the installations which have been erected, or are in process of erection, in Germany will show the progress acetylene has made in this direction:—

Name of Erecting Firm.	Town.	Number of Inhabitants.	Price of Gas per Cubic Metre.
			M. pf.
Schilling and Guttzeit, Königsberg	Sensburg	3562	..
	Bischofswerder	1148	..
	Passenheim	1967	..
	Johannisburg	3000	..
	Frauenburg	2458	..
	Saalfeld	2517	..
	Guttstadt	4504	2 50
	Ratzebuhr	2298	..
	Pr. Friedland	3518	..
	Arys	1324	..
Welkoborski, Giessen	Grossenlinden	..	2 80
Keller and Knappich, Augsburg	Hassfurt	2500	2 40
Allgemeine Acetylen-und Carbid-Gesellschaft, Berlin	Oliva	4212	..
	Schönsee	1536	..
	Ellerbeck	4176	..
	Neunkirch	..	..
Hera-Prometheus, Berlin-Leipzig	Strelitz	5000	1 90
	Treptow	4363	..
	Peiskretscham	4500	..
	Sulzburg	1111	..
	Allendorf und Bad Sooden	6000	..
	Schlangenbad	382	..
	Dürrenburg	..	..
	Achim	3500	..
Welkoborski, Giessen	Daaden	1767	2 20
Deutsche Acetylengas-Gesellschaft, Berlin	Kirchenditmold	..	..

Works are projected in Sprendlingen, Grossbeeren, Darnnenberg, and Trimmen.

In addition to these gas-works for small towns, there are more than 100 installations burning upwards of 500 jets.

In order to give a clear description of the generation and purification of the gas in an acetylene gas-works and the distribution of the gas to the consumers, the installation at Treptow has been selected from the above list.

The works lie about 300 yards from the railway station, and consist of a dwelling-house for the engineer, with office; a building for the generators, purifiers, &c.; a carbide-shed, having a storage capacity of 40,000 kilos.; two pits for lime sludge; and a well for the necessary water. The works were constructed for a daily production of 200 cubic metres, with an estimated consumption of 2000 jets of 32-candle power, burning simultaneously. The material used was strong boiler-plate, firmly riveted together. The generators are fed by hand according to the "carbide to water system;" the gasholder has a total capacity of 50 cubic metres; and the tank is of wrought iron. The purifying substance is "heratol"—Ulmann's system of purification by means of chromic acid dissolved in sulphuric or acetic acid.

After generation, the gas passes through the condensers into the washer, where the ammonia and, to a slight extent, the sulphuretted hydrogen are absorbed. The washer also serves, by virtue of its construction, as a safety-valve. If one of the generators is being cleaned or repaired, and the workman omits to close the valve, it is impossible for the gas in the holder to return and escape. The gas now enters the holder, and thence passes through the purifiers. The purifying substance absorbs the sulphur and phosphorous compounds of the gas, which passes through the dryer, gas-meter, and pressure-regulator, and then enters the main-pipes. The works are heated by steam in winter, and are lighted by jets, with reflectors placed outside the windows.

The pipes were originally laid with a view to a possible total consumption of 2000 jets, in order to prevent expenditure for extension in the future. The main-pipes have a diameter of 2 and 3 inches, and are constructed of wrought iron. Cast-iron pipes have not given in all cases satisfactory results. It must be remembered that the leakage from acetylene pipes means a much greater loss than the leakage of the same amount of coal gas, and that therefore the greatest care must be observed to render the pipes as air-tight as possible. The piping possesses a total length of about 5 miles, and is carried over several bridges encased in sawdust wrapping.

In order to investigate whether the above-mentioned towns were satisfied with the new lighting, the German Acetylene Society issued a circular, asking them to express their opinions in this respect. Many of the towns responded; and although the answers contained many inaccuracies, they were unanimous in affirming their satisfaction. As a rule, the municipal authorities themselves manage the gas-works; but in some cases the management has devolved upon private companies. Only one disturbance in the system of lighting was reported. The price for 1 cubic metre of acetylene is 1s. 6d. to 2s. in towns with municipal management, and from 1s. 10½d. to 2s. 6d. in towns with private management. In most cases the total system of piping is not yet completely utilized, probably because it was purposely laid down in excess to meet future demands. The gas is used not only for lighting purposes, but also for cooking and driving gas-engines. The Ellerbeck Acetylene Gas Company sell acetylene for engines at 1s. 2½d. per cubic metre—a great reduction on the price for lighting purposes.

As will be seen from the above statistics and details, the almost unanimous verdict passed by gas engineers a few years ago in Germany with respect to the impossibility and undesirability of acetylene gas-works has been completely refuted. It is considered to be a matter for congratulation that such important installations are beyond the power of the untrained inexperienced mechanic, who is still felt to be mainly responsible for so much of the suspicion with which acetylene is yet regarded in many quarters, and can only be carried out by firms of repute with a theoretically and practically trained staff.

The increase in the production of carbide, and the reduction in price, seem to indicate that acetylene, instead of being used only for the lighting of small towns up to 8000 inhabitants, may come to be used for the lighting of larger ones. The greater demand for carbide which would result in this case will be probably supplied by the utilization of the waste gases of blast-furnaces. The amount of carbide consumed by acetylene works is not very great. It may be liberally computed at about 65 to 70 tons per annum for an installation with 2000 jets. Assuming that the 30 installations in Germany used this amount annually, which is certainly not the case, this would give a total annual consumption of 2100 tons for gas-works. Assuming further, according to the present method of carbide manufacture, that 1-horse power produces 1 ton annually, the total consumption of the 30 gas-works could be provided for by a carbide works of about 2100-horse power. This is by no means a large amount, as the German railways alone will consume 8000 tons of carbide this year.

Up to the year 1870, railway carriages in Germany were lighted by candles or oil-lamps. As this method of lighting was gradually found to be insufficient, and petroleum could not be used on account of the danger of fire, the attention of the authorities was directed to gas lighting. Coal gas, unfortunately, was found to be unsuitable, as its illuminating power decreases under pressure; and it is only in a compressed state that gas for lighting railway carriages can be carried, as the iron cylinders in which it is contained would otherwise attain too large dimensions. Experiments were then instituted with oil-gas manufactured from gas oil, a bye-product of the distillation of lignite coal. The results proved favourable, especially as it was found that oil gas could endure a pressure of 10 atmospheres without showing any appreciable diminution in lighting power, and could therefore be carried in small cylinders. The introduction of oil gas was accordingly decided upon; the wholly necessary installation—a simple one—consisting, in addition to the iron cylinders, of pressure-regulators, in order to reduce the pressure of 6 atmospheres in the cylinders to 1½ inches water-gauge pressure at the burners. This new method of lighting railway carriages was carried out with great speed, especially in Prussia. One firm alone, that of Julius Pintsch, of Berlin, had fitted out 6000 carriages in 1880, 32,000 in 1890, and 89,000 in 1898.

In the meantime, however, the science of illumination had made further progress, especially in the improvement of electric lighting and the invention of the Auer incandescent mantle. The quality of oil gas, on the other hand, had considerably declined, owing to a deterioration in the properties of the gas oil. For instance, a jet consuming 27·5 litres (0·96 cubic foot), and giving originally 7 to 8 normal candle power, had decreased to 5 normal candle power. This defect was experienced so keenly that in 1895 several authorities were seriously considering the question of the introduction of electric light. About this time the discovery of the manufacture of calcium carbide on a large scale drew attention to acetylene, especially as it was soon observed that it could be used in carriages with oil-gas installations without any further necessary alterations. Even if the estimated expenditure for acetylene had been in excess of that for electric lighting, the important fact that the oil-gas installation could be utilized for its introduction would have decided the case in its favour. The Prussian railway authorities commenced experimenting with pure acetylene in 1896, and upon the occasion of the annual meeting of the German Railway Directors' Society, they exhibited with great success a train lighted throughout by acetylene, the only drawback being the formation of soot at the burners—a defect which was easily remedied by the adoption of a suitable new form of burner. A beginning was now decided upon, and an acetylene gas works erected at Berlin, near the oil-gas works.

In the autumn of the same year, several explosions caused by the compression of acetylene occurred, which caused the railway authorities

to pause for a time, and institute experiments on the liability to explosion of compressed acetylene. These were carried out at Fürstenwalde, and proved that the use of compressed acetylene, under the normal conditions of railway traffic, actually contained the elements of danger in addition to the possibility of explosion during the process of compression. Attempts were then made to avoid this danger by mixing acetylene with oil gas; and for this purpose mixtures of from 80 to 25 parts of oil gas with from 20 to 75 parts of acetylene were selected. It was found that a mixture containing as much as 50 per cent. of acetylene was as little liable to explosion as the ordinary pure oil gas hitherto used. Careful photometric measurements showed further that the illuminating power of oil gas was considerably increased by the addition of acetylene—a mixture of 75 parts of oil gas and 25 parts of acetylene giving no less than three times the illuminating power of 100 parts of pure oil gas. This gas mixture permitted further the use of the oil-gas burners, which cannot be used for pure acetylene, as they cause the jets to smoke and become choked through the formation of soot. These considerations were instrumental in determining the general adoption of the above-mentioned mixture. Should it be found necessary to increase the amount of acetylene to 50 parts, this can be effected without any change in the construction of the compressing machinery and gas-fittings.

After the first acetylene oil-gas works had been erected near Berlin, in September, 1897, the Berlin town and ring railways were supplied with the new system of lighting; and shortly afterwards the local and some long-distance lines. In October, 1899, all trains within the Berlin railway district had been fitted up, for which five acetylene oil-gas works were found necessary. The amount of carbide required for this purpose for the Prussian railways amounted to 980 tons for 1898, to 3000 tons for 1899, and is estimated at 4500 tons for 1900. The acetylene oil-gas system of lighting has now been in use for two years, and has proved completely satisfactory in every respect. The other German State railways are following suit; so that in 1900 about 8000 tons of carbide will be consumed in Germany for railway lighting purposes alone. The Bavarian railway authorities are devoting special attention to acetylene lighting, not only for railway carriages with the oil-gas mixture, but also for the lighting of stations with pure acetylene. A beginning was made with the stations at Hochzoll and Hergatz, as an experiment. This proved so satisfactory that it was followed by the introduction of acetylene gas at the stations of Hassfurt and Oberhausen.

The cost per cubic metre of oil gas, according to Railway Director Bork, compared with pure oil gas and acetylene, is shown for the year 1898, shortly after its adoption, by the following figures: Oil gas, 30 pf.; acetylene oil gas, 54 pf.; and acetylene, 1 m. 30 pf.

The cost of the gas consumption per jet is—

—	Hourly Consumption.	Cost.	Normal Illuminating Power.
	Litres.	Pf.	Candles.
Oil gas	27·5	0·825	5
Acetylene oil gas . .	27·5	1·485	15
Acetylene	12·0	1·560	15

To the cost as given above must be added the expenditure for wear and tear, maintenance, interest on capital, &c., which amounts to about 0·8 pf. per jet an hour; so that the following figures result: Oil gas, 1·625 pf.; acetylene oil gas, 2·285 pf.; acetylene, 2·36 pf. The cost for 1 normal candle power, with an hourly consumption of 27·5 litres for oil gas and acetylene oil gas, and 12 litres for acetylene, is—

Oil gas . . . . . 1·625 ÷ 5 = 0·325 pf.
Acetylene oil gas . . . . . 2·285 ÷ 15 = 0·152 pf.
Acetylene . . . . . 2·360 ÷ 15 = 0·158 pf.

These figures show that in 1898 the new system of lighting with acetylene oil gas cost per hour and candle power only half the former lighting by oil gas; further, that acetylene oil gas and acetylene were equal in price. Since that time the carbide prices have sunk considerably, and have correspondingly reduced the cost of lighting by acetylene and acetylene oil gas. In January, 1898, 1000 kilos. of carbide cost 400 marks; in June, 1900, the price for the same quantity stood at 270 marks.

At an early stage of the progress of acetylene lighting, it became evident that all the advantages accruing from the adoption of acetylene would be rendered illusory if the insurance companies were to refuse policies or exact premiums which would practically prove prohibitive. Bearing in view the great economical importance of this question, the Acetylene Society placed themselves in communication with the representatives of the German private insurance companies in order to facilitate a solution which would be satisfactory to both parties. After many meetings had been held, and concessions granted on both sides, a list of conditions was ultimately formulated and accepted. Great satisfaction is expressed that a basis has been formed which, on the one hand, places the German acetylene industry on a safe footing; and, on the other hand, secures ample guarantees for the insurance companies. . . . The broad and liberal standpoint adopted by the companies during the negotiations was most commendable. They asserted that there was no desire to take up an inimical or unfavourable attitude towards acetylene gas lighting; that every improvement in the methods of lighting represented an advance in culture and in refinement, which benefited, not only industries, but also private individuals; and that, finally, for this very public reason, less than for any personal aims, the greatest care was called for, even to the extent of precautions which might, at first sight, appear unnecessary.

With regard to the conditions themselves, they contain the following precautionary measures:—

1.—The gasholder must be provided with a safety-valve.
2.—The installation must be provided with a purifying apparatus.
3.—Generators and gasholders must be isolated by walls of non-inflammable materials.
4.—Inflammable substances must not be stored in the apparatus chambers, which must be always well ventilated.
5.—The preparation, storage, and use of compressed acetylene is not permissible. The expression "compressed" applies to acetylene under a pressure of more than one atmosphere.
6.—Further regulations regarding size of piping and storage and isolation of carbide.

In reviewing the progress and the present condition of the acetylene industry in Germany, it is impossible to overlook the valuable work done by the German Acetylene Society under the able direction of the President, Professor Dieffenbach, of the Darmstadt Polytechnic School. Founded in November, 1898, by the fusion of two smaller Societies, it was immediately joined by 110 members. The roll of membership at the present time counts 370 members, including almost all the principal acetylene chemists, engineers, directors, and owners of works in Germany, besides many from foreign countries.

A special and most important feature of this Society is the existence of Sub-Committees whose duty it is to discuss matters connected with the various branches of the acetylene industry. The General Committee consists of engineers, chemists, manufacturers, one patent agent, one lawyer, one director of an insurance company, and an inspector of buildings. The Chemical-Physical Committee consists exclusively of a small number of chemists and physicists. The Technical Committee consists principally of engineers and chemists. The Commercial Committee resembles the General Committee in its constitution, but contains fewer members. The organ of the Society is "Das Acetylen." In order to increase the efficiency of the Society, it has been decided to form sections in the different German States.

The following vital questions, whose satisfactory solution is of the greatest importance to the acetylene industry, have either been finally settled or are at the present time under the consideration of the various Committees:—

The construction of generators: (*a*) Materials to be used and strength of the same; (*b*) methods of generation permissible.
Calcium carbide: (*a*) Necessary average quality of the same, method of packing; (*b*) normal methods of analysis.
Purification of acetylene: (*a*) Construction of purifier; (*b*) purifying materials.
Negotiations with the competent authorities on the carriage of carbide (*a*) by rail, and (*b*) by water; and on (*c*) the storage of carbide in large and small quantities.
Negotiations with fire insurance companies.
Official investigation of all explosions asserted to have been caused by acetylene.
Prevention of certain commercial abuses at present prevalent in the carbide trade.

The Society have also placed their services at the disposal of all State and Local Authorities who are in any respect interested in acetylene lighting; and they have experienced the gratification of seeing the offer in many cases thankfully accepted.

The pioneers of the German acetylene industry recognized at an early date the great value of annual and other meetings, where engineers, chemists, and owners and directors of works assemble together to survey the progress already made, to discuss disputed questions, and to decide upon normal regulations for the industry. The first congress was held in Berlin, in March, 1898; and the second in Nüremberg, in July, 1898. In October, 1898, a general meeting of the Calcium Carbide and Acetylene Society was held at Frankfort-on-the-Main; and in May, 1899, the International Acetylene Congress, held at Buda Pesth, was attended by a large number of German acetylenists.

The German Acetylene Society held their first annual meeting at Nüremberg in October, 1899, and the second at Düsseldorf in September, 1900. In addition to these, the Sub-Committees have been most actively engaged upon the various questions submitted to their consideration, and have held, in the present year alone, no less than ten meetings. The Society have been most active in furthering the holding of acetylene exhibitions, which have greatly accelerated the progress of acetylene lighting. The importance of these periodical industrial reviews has been clearly recognized, and their opportunities fully utilized. The first exhibition was held at Charlottenburg in March, 1898, and was supported by about forty German firms, in addition to several from Austria-Hungary, Switzerland, France, the United Kingdom, Russia, and Denmark. The exhibits included generators, purifiers, mixed-gas apparatus, burners, acetylene gas-engines, carbide, electrical furnaces, and various machines used in different branches of the industry. The second, held at Nüremberg in June, 1898, was on a smaller scale. The exhibiton at Cannstatt in May, 1899, attracted no less than 110 firms, several from the United Kingdom, France, and Germany being among the number. The Jury who awarded the gold and silver medals at this exhibition excluded from competition all generators working with a pressure of more than half an atmosphere, all generators in which the water drips on the carbide, and, finally, all those which were not shown in action. The German industry was represented at the London Exhibition in June, 1898, by three firms, and at the Buda Pesth Exhibition in May, 1899, by ten. The acetylene section of the Paris Exhibition was entirely neglected by the German industry for various reasons.

Hartlepool Gas and Water Works Purchase Question.—A statutory meeting of the ratepayers of West Hartlepool was held yesterday week for the purpose of passing a resolution confirming the promotion of a Bill authorizing the purchase of the Hartlepool Gas and Water Company's undertakings by the two local Corporations. The Mayor (Alderman Macfarlane) presided, and, in proposing the resolution, said the question of purchase had been, during the past three years, gradually forced on their attention; and the Corporations had, after thorough inquiry, considered it their duty in the interests of the public, to take this step. Alderman Furness, in seconding, said the Joint Committee of the two Corporations had unanimously recommended purchase. Until this time the Corporations had never been so united as to admit of the question being jointly dealt with. Mr. Loveridge, in urging the inopportuneness of purchase just now, suggested that they should wait until the electric lighting system was put on a first-class footing, when, he contended, they would be able to buy the undertaking cheaper. Mr. Robinson held that delay would only mean that they would have to buy at an enhanced price. Mr. Furness supported this, and observed that, from the procedure that would have to be followed, he was fully convinced they would not have to pay more than the undertaking was worth. After some further discussion, the resolution was put and unanimously adopted.

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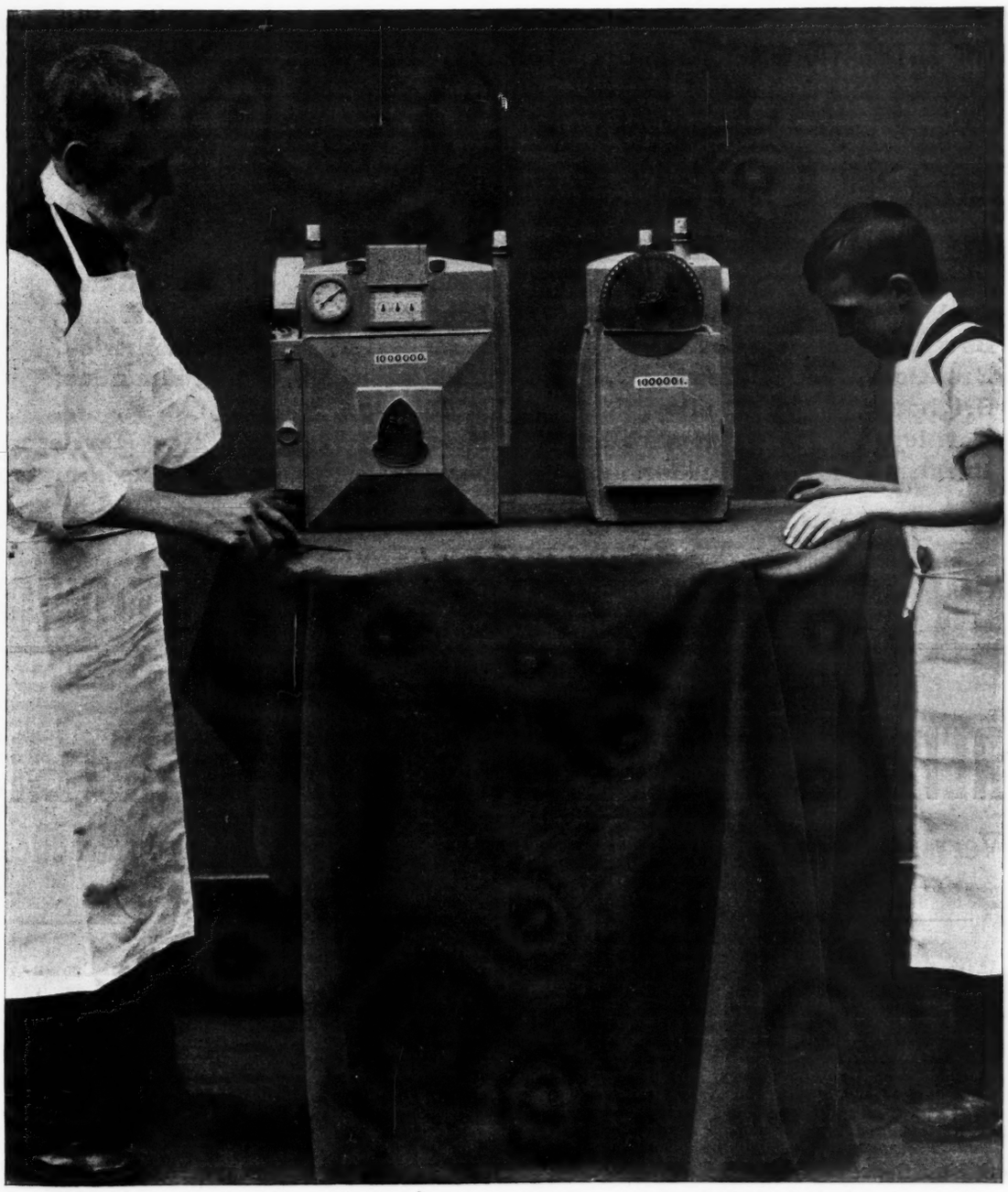

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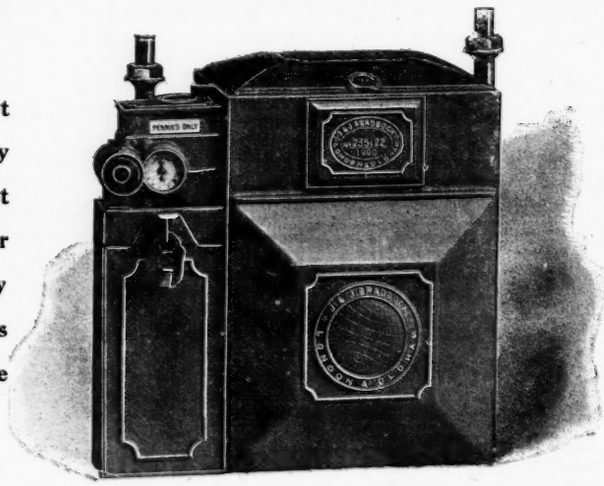

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EXPLOSIONS OF GAS.

A serious gas explosion, involving the loss of two lives, occurred at Dundee last Thursday night on the premises of Messrs. Smith Bros., tailors and outfitters, Murray Gate. A workman was engaged in searching for an escape of gas when an explosion took place in the basement, blowing out the front windows of the shop, and wrecking the greater part of the building. A porter named Allan Ferguson and an apprentice boy named Richard Cameron were killed; their bodies being found buried in the ruins. Thirteen girls (machinists) were injured more or less seriously; one of them having both her legs broken, while a second is believed to be fatally hurt. At Lynwood Villa, near Braintree Parish Church, on the morning of the above-named day, Elizabeth Cannon, a servant, entered the study with a lighted candle, and as she was about to light the gas a violent explosion occurred, completely wrecking the house. Windows were blown out, doors forced from their hinges, the outer walls of the house were bulged, and the chimney-stack was split. The girl was badly burnt about the head and hands, and was removed to Brentwood Hospital; while another servant was severely burnt. The other occupants of the house escaped injury. A correspondent has sent us the following account, from a local paper, of a gas explosion which recently occurred at Barnstaple: On the outside of the back-seat door of the Music Hall, and on the top of a flight of steps leading to the Oddfellows' Hall, is a gas-standard hanging from the ceiling. This had been taken away to be repaired; the man turning off the gas at the meter. He returned an hour afterwards and refixed the standard, turning on the gas. As a proof that no smell of gas was detected, he lit the two burners with safety. Then, standing on a pair of steps, he proceeded to apply a lighted match to the ball of the standard, close to the ceiling, to see if the fitting was right, when there followed a loud report, and the place was filled with flames. The man jumped off the steps, and ran down the long side passage of the Music Hall. There was no outlet for the ignited gas, and it descended to the bottom of the flight of steps, which abut on Boutport Street, and burst open the double doors, wrenching the locks and hinges, and splitting some of the wood into splinters, but not injuring the fanlight or the window at the top of the steps. The right hand and arm of the workman were slightly burnt.

CHELSEA WATER-WORKS COMPANY.

The Half-Yearly General Meeting of this Company was held at the Office, Commercial Road, Pimlico, last Thursday—Mr. F. S. Clayton in the chair.

The Secretary (Mr. G. H. Gill) read the notice convening the meeting, and subsequently the certificate of the Government Auditor and the report of the Company's Auditors.

The Governor, in moving the adoption of the report, stated that the gross income for the half year to Sept. 30 amounted to £89,121, including an increase of £1750 in the water-rental. The working expenses had been £28,257, which was about £2000 more than for the corresponding period of the previous year. This was caused entirely by the higher price of coal and by the larger amount paid in the half year for law and parliamentary expenses. Nevertheless, the Directors were able to recommend the same dividend as on the previous occasion—viz., at the rate of 11 per cent. per annum—and carried forward £2753. Apart from the two items mentioned, the ordinary expenditure on maintenance and management had been quite normal. The increased amount of the law and parliamentary expenses had been caused chiefly in opposing Bills in Parliament affecting the Company's interests. One of these measures was an electric tramways Bill, to oppose which had been a very costly process, as the Directors had had to send an expert to Kingston, where the inquiry was held. In the result, the proposed measure was rejected. He might state, with regard to the question of electric tramways or light railways, that it was important for suppliers of water—and the same remark applied to those who supplied gas—to bear in mind the dangers which arose from electrolytic action on their mains. This matter had become so serious that the gas and water companies were uniting in order to bring pressure to bear on the Board of Trade to introduce some new regulations on the subject; it being manifestly unfair to companies and public authorities who supplied water and gas that the whole cost arising out of this new danger should be thrown upon them. The Company's new supplies in the half year numbered 398, which were estimated to produce a net annual addition to the water-rental of £1473; and 59 houses had been pulled down for improvements—representing a temporary loss of income of £68. To meet extensions in the district 1202 yards of service mains had been laid during the half year. The extension of the service reservoirs on Putney Heath was completed last June; and a scheme had been prepared, under the Act of 1899, for the purpose of establishing intercommunication between the systems of the different Water Companies. Revised regulations for the prevention of waste had been agreed upon by the respective Companies, and had been sent to the Local Government Board for confirmation. The London County Council had promoted a Bill for acquiring the interests of the Companies; and therefore he supposed that it would be necessary for them later on to incur the expense of protecting themselves, though they knew that the proposals of the Council would be opposed by the Government, who would probably introduce a Bill in the session of 1902. He believed he was correct in stating that, since their existence, the Council had introduced altogether 24 Bills relating to the Water Companies, and that not one of those measures had received the assent of Parliament—in fact, the Council had been defeated all along the line in dealing with the Companies. It was impossible to say what attitude the Government would take in 1902; but he thought there was good reason to suppose that they would carry out the recommendations contained in the report of the Royal Commission.

The Deputy-Governor (Mr. Jackson Hunt) seconded the motion; and it was carried unanimously.

A resolution was afterwards passed declaring the dividend recommended—5 per cent., with an additional ½ per cent. on account of arrears; and the proceedings closed with a vote of thanks to the Governor, Directors, and staff.

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ELECTRIC LIGHTING NOTES.

The Local Government Board have declined to sanction the borrowing of £10,000 for the purposes of free wiring at Swansea. The National Free Wiring Company will now do the work.

The formal opening of the Stockton Corporation electric lighting works took place last Tuesday. For this undertaking the Local Government Board permitted the borrowing of £24,482; and in July, 1899, the ceremony of laying the foundation-stone was performed by Mrs. Ford. Unfortunately, through indisposition, the Manager of the gas and electrical works (Mr. W. Ford) was unable to be present on Tuesday, to see the practical consummation of the work which he has had the responsibility of constructing and supervising. However, there was a large attendance at the works, to see Alderman Hind set one of the engines in motion; and in commemoration of the event, he was presented by the Contractors with a beautiful bronze standard electric lamp. In an address, Alderman Hind stated that at the time the Corporation applied for an Electric Lighting Order, they were face to face with the fact that the consumption of gas was going up by leaps and bounds; and Mr. Ford reported to them that the gas-works, being at their utmost limits, would have to be extended at a cost of £30,000. The Committee, however, decided that, if it was necessary to expend this sum, it should be laid out in electric lighting plant. The speaker proceeded to laud the virtues of the electric light and disparage gas, when some of the polish was taken off the comparison by "darkness coming o'er the scene" for the space of a couple of minutes. Of course, as the Alderman said, such little incidents are inseparable from an opening day; and we may inform the Alderman that such incidents are not unknown after opening days. The Committee are happy in the extent of the demand they have had for the light. Customers to the number of 75 have applied for 5700 16-candle power lamps, exclusive of street lighting.

ILKESTON AND HEANOR WATER SCHEME.

The Estimated Cost.

A Special Meeting of the Ilkeston Town Council was held last Tuesday to consider and seal a petition for the Bill by which it is proposed to constitute a Joint Board representative of the Ilkeston Corporation and the Heanor District Council, with power to acquire the undertaking of the Meerbrook Sough Company, and to construct works for intercepting and distributing water from that source. The most important part of the proceedings was a statement by the Town Clerk (Mr. Wright Lissett) regarding the cost of the scheme. In the first place, he said, the payment to the Company for the sough would be £5000—£6000 altogether, because the Board would have to pay interest, &c. The total cost of the works to deliver water to Chadwick Nick reservoir—that was the reservoir it was proposed should be constructed in connection with the scheme —would be £56,820. The two sums made £62,800; and this was the cost of the works and machinery necessary for putting the water into the reservoir. The outlay on land, easements, compensation, reservoir at Chadwick Nick, and pipe-line from Chadwick Nick to Heanor (and forward to Ilkeston) was estimated at £49,680; so that the total cost of the works to be constructed by the Joint Board would be £112,500. Then they had £9500 in the Bill for the reservoir at Ilkeston, and £12,000 for the reservoir at Loscoe and Codnor. These sums would have to be borne respectively by Ilkeston and Heanor. The Town Clerk then gave an estimate of what it would cost for repayments and interest on the sixty years they were asking for in the Bill. A resolution adopting the petition was passed. Last Thursday, the ratepayers of Heanor, in public meeting assembled, also consented to the promotion of the Bill.

A LARGE ITALIAN WATER SCHEME.

The Italian Government have just given orders for the execution of a scheme which had been under consideration for several years, with the object of supplying the provinces of Bari, Lecce, and Foggia (Apulia) with water. The total length of the aqueduct is about 1660 kilometres 262 being for the principal aqueduct, 110 for the secondary branch conduits, and 1288 for those under pressure. The principal aqueduct will consist of 59 kilometres of tunnel and 188 kilometres of trench. The water will be obtained from the Caposele springs, situated at an altitude of 418 metres in the Apennine Mountains, where many of the peaks attain heights of 1600 to 1800 metres. The minimum utilizable discharge is 2·5 cubic metres (550 gallons) per second. The aqueduct is to supply 218 towns or important villages, the population of which will probably be 1,850,000 in 1911, the time estimated for the completion of the works. The scheme has been designed to furnish 150 litres (33 gallons) per head per day in localities of more than 40,000 inhabitants; 100 litres in those of 20,000 to 40,000; 75 litres in those of 10,000 to 20,000; 60 litres in those of less than 10,000; and 50 litres in those where pumps are needed. There are to be 89 reservoirs of a capacity of 121,500 cubic metres, or rather more than 2½ million gallons, along the line taken. Instead of the aqueduct being circular in section—a form which would have made it necessary to run off all the water for repairs, and to construct large reservoirs near each point supplied—it is arched, with a banquette wall running along the centre, so that when one half is being repaired water can flow through the other. Each of the channels thus formed suffices for a discharge of 220 gallons per second. The banquette serves as a road for inspection. The free space above it to the intrados of the vault is 5 ft. 8 in. The profile of the aqueduct varies with the ground. In clayey soils, where masonry is at times subjected to considerable pressure owing to slips and subsidence, the arches are oval; and in compact soils of great resistance projected piers with vertical interior facing are adopted. In very hot places, there are pillars and insulating air cushions on both sides to prevent heating of the water. The estimated cost of the aqueduct is £6,524,000.

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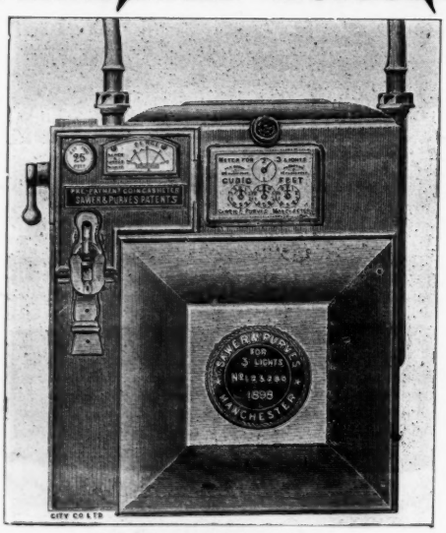
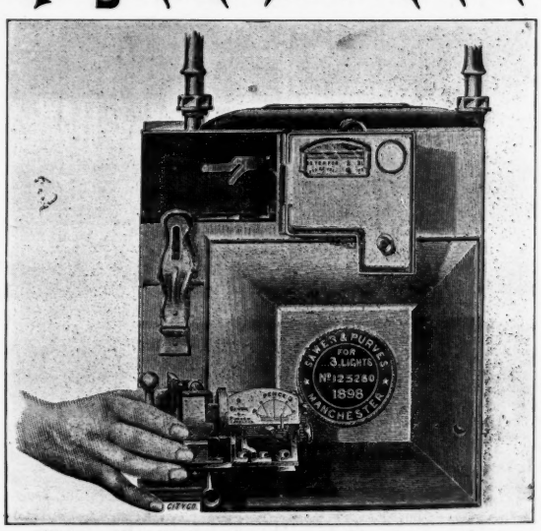


Meter in working position.



Meter with attachment removed without uncoupling.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

The Dumfries Gas Commissioners have lately had before them a report by Mr. T. M'Lintoch, of Glasgow, upon the defalcations of the late Cashier (Mr. J. Herries), who, when his system of defrauding was discovered, committed suicide. Dealing with the seven years from 1893 to 1900, Mr. M'Lintoch brought out a loss to the Commissioners by the defalcations of £989, to which there will fall to be added further sums, to be adjusted at the end of the current financial year. Mr. M'Lintoch recommended the adoption, in May next, of a set of books upon a different system. According to his report, the defalcations were carried through by the Cashier preparing false sheets showing the gas-rental to correspond with the cash, and presenting these to the Auditor instead of the gas-rental book. The presentation of the report was followed by a discussion, in which some speakers thought that the Auditor was to blame for not seeing the books, and others pointed out that the Auditor had only been in office for three years, and that it was he who, notwithstanding the subtlety of the defaulter, discovered that there was something wrong. In short, the great question of the rights and duties of auditors was raised. Much was made of the remark of Mr. M'Lintoch that he would not have accepted the rental-sheets which the Cashier produced, but that he was a man of much greater experience than the Auditor. This remark strikes at the bottom of the whole matter. An auditor should take nothing for granted. In this instance, the Auditor had made the remark that the books were obsolete; and he was met by the Cashier with the reply that they had satisfied previous auditors, and he did not see why they should not satisfy him. Such an observation should at once have aroused suspicion; and probably it did, because it was after this that the Auditor discovered the frauds. No one—not even the speakers who wished the subject further considered in committee—sought to throw the slightest blame on the Auditor, except for having erred in judgment. That he did so at first is undoubted; but it is equally true that he came to a right conclusion in the end, to the effect that there was something wrong. The difficulty he must have had in arriving at this conclusion is well exemplified by the remark of Provost Glover, to the effect that "Mr. Herries was held up as a phenomenon of integrity and probity." An auditor newly appointed would scarcely dare to question the work of an immaculate man like that. Yet it was his duty to; and an auditor who fails to look into every nook and cranny in the workshop of a book-keeper fails in his duty. The Commission adopted Mr. M'Lintoch's report. So far as I can read, there still remains for decision the question of liability, if any exists, for the losses which have been incurred.

Power to supply electricity in bulk is sought in a Provisional Order which is about to be promoted by the Caledonian Electric Company, who propose to adopt as their field of operations the counties of Dumbarton, Ayr, and part of Lanark. The measure, it is understood, is to be opposed by the County Council of Lanark; and a circular has been issued by the Secretary of the Bellshill Gas Company suggesting a conference of all the gas companies in the counties interested, to fully consider the matter and its probable effect on them. In such cases, the difficulty is to get someone to move first; there being a disposition for one to wait for the others.

At a meeting of the Gas Committee of Dundee Town Council last Tuesday, the Analyst reported that during the past month four firms supplying coal had sent supplies below the contract quality, and the Town Clerk was instructed to write them in the same terms as he did to the others against whom a similar allegation was made. Replies were received from three firms which had been previously communicated with. One of them repudiated liability in the matter, and stated that if the coal was below the contracted quality the depreciation must have been caused by the wet weather. The Analyst, however, stated that the coal was tested when it was perfectly dry. The other two firms expressed regret that there should have been complaints, and one of them suggested that the coal might not have been properly screened. Mr. High repeated his former statement, that a sum of £3000 was lost last year owing to defective coal. The Convener (Mr. Ballingall) replied that the statement was incorrect. He produced figures to show that the cost of extra coal was £1150 odd, and that of this sum £156 was accounted for by extra gas being produced; so that the loss through bad coal was about £1000. The remainder of the £3000 went in increase of wages.

The Perth Police Commission a short time ago received a letter from Sir Robert Moncreiffe asking on what terms the Commissioners might be disposed to take over the Bridge of Earn Gas Company and the lighting of the village. At a recent meeting of the Company, it was thought that before there could be any increase in the supply, a new holder would have to be erected, and that the Company and the Police Commissioners of Perth might be mutually benefited by the supply being obtained from Perth. The Gas Company at Bridge of Earn was formed in 1859, when the works were built at Sealsbridge. The pipes were then laid throughout the whole village, and to Moncreiffe and Kilgraston mansion-houses. Since then Dunbarney House and Drummonie House have been added to the list. The price of the gas originally was 10s. per 1000 cubic feet. It was ultimately reduced to 6s. 8d.; and the consumers are now paying 6s. 3d. per 1000 cubic feet. The present price is largely prohibitive to the people in the village and in Kintillo. The plant consists of a bench of three retorts—two fireclay and one iron; and there is a full equipment of condensers and lime purifiers. The yearly consumption is about 1,250,000 cubic feet; and of this quantity only about one-third is consumed in the village—the remainder going to the two large mansion-houses above mentioned. The village is lighted by an excellent arrangement of street lamps. The work was taken in hand a few years ago by Mr. J. Ellis, who, with a small Committee, year by year raise the necessary funds by subscription in the village. It is thought that if the gas could be had from Perth at a reduced rate, all the people in the district would use it, as every house is fitted with pipes. As Scone gets its supply from Perth, the villagers see no reason why Bridge of Earn should not have the same privilege; for with the erection of the new gas-works at the Friarton they are practically as near Perth as Scone is.

The "CZARINA."

SEASON 1900-1.

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CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *Dec.* 21.

Sulphate of Ammonia.—There has been good demand throughout the week, and prices have improved about 1s. 3d. per ton all round—the closing quotation being £10 16s. 3d. per ton f.o.b. Hull, £10 18s. 9d. f.o.b. Liverpool, and £11 f.o.b. Leith. It will be observed that Scotland is still the best market. The bulk of the buying appears to be for covering purposes, direct orders being still scarce, and consumers being mainly interested in the forward position. It is reported that £11 5s. per ton has been paid for January-September delivery, f.o.b. Leith; but for January-March or January-June, the quotation remains £11 7s. 6d. per ton. Beckton terms is also quoted £11 7s. 6d. per ton.

Nitrate of Soda is steady at 8s. 3d. per cwt. for ordinary, and 8s. 6d. for fine, quality.

LONDON, *Dec.* 22.

Tar Products.—The contrast between the position of this market to-day and the corresponding period last year places tar distillers in an unenviable position. For some months past, there has been a continuous tendency to weakness, and lower prices in most of the products; and stocktaking will bring an unhappy issue to many works, especially those who entered into long contracts for tar at comparatively high prices. The serious factor at the moment is the low price and unsaleableness of creosote and other tar oils, which appear to be in over-production, though it is thought the greatly reduced value is largely due to the very low prices at which Scotch oils are being quoted. Pitch only just maintains its own, although the last day or two is marked by a little more inquiry. Benzols are moderately steady, naphthas in moderate request, and carbolic is doubtful, though there are sanguine expectations of better prices. Naphthalene is steady, anthracene neglected, and tar quoted lower.

The average values of the week are: Tar, 14s. to 18s. Pitch, East Coast, 30s. to 33s., according to port; west coast, 28s. to 30s. Benzol, 90's, 10d. to 1s.; 50's, 1s. 1d. Toluol, 1s. 3d. Solvent naphtha, 1s. 1½d. Crude naphtha, 4⅛d. Heavy naphtha, 1s. Creosote, nominal, 1½d. Heavy oils, 2½d. Carbolic, 60's, 2s. 5d. Naphthalene, 90s.; salts, 60s. Anthracene "A," 3½d.; "B," 2d.

Sulphate of Ammonia has displayed a greater activity during the week. A considerable business is reported; and the position is fairly firm, while for forward delivery buyers are plentiful. Value closes about £10 17s. 6d., less 3½ per cent.

COAL TRADE REPORTS.

From Our Own Correspondents.

Lancashire Coal Trade.—The year is closing with a generally steady tone in prices for all descriptions of fuel—at any rate so far as current quotations are concerned. The Lancashire Coal Sales' Association have, in fact, had the question of prices under consideration during the past week; and a very strong view prevailed as to maintaining them at least on the present basis. The renewal of contracts for the ensuing year is, however, causing some anxiety in the district. During the last couple of months, negotiations have been going on with the Alkali Union, who are perhaps the largest users of engine fuel in the district; but no definite result has been come to, and the Lancashire collieries have at last decided to practically suspend further negotiations unless the Union are prepared to pay their prices. In the meantime, the Union are endeavouring to obtain supplies in other districts; and inquiries have been put forward in Yorkshire. With regard to round coals the position is also much the same; and there are lively anticipations of the contention which is likely to arise when the larger contracts come up for renewal early next year. One thing is certain—that they will only be renewed by consumers at prices considerably lower than those that were paid this year. So far as current business is concerned, house coals are moving away readily, at the full list rates of 16s. 6d. to 17s. 6d. per ton at the pit for best Wigan Arley, 15s. to 15s. 6d. for Pemberton four-feet and seconds Arley, and 14s. to 14s. 6d. for common house coal. Steam and forge coals are also in steady demand, at about 12s. to 12s. 6d. per ton. For engine fuel there is a fairly active inquiry generally, with 10s. 6d. per ton at the pit about the average price for good medium sorts. Coalowners are moving away practically all they are raising, and consequently are in a position to hold to prices with firmness at present. Steam coals are readily obtainable at about 15s. to 15s. 3d. per ton delivered at the Mersey ports.

Northern Coal Trade.—Now that work has been fully resumed on the railways, there is a large output of coal, and the shipments are heavy. It is tolerably certain that this condition of the trade will go on until the holidays; for there is a little deficiency to overcome that the recent strike caused, the deliveries during that time having been much below the average. In the steam coal trade the demand is moderate. Best Northumbrian steam coals may now be quoted at from 13s. 6d. to 14s. per ton f.o.b.; while steam smalls are 7s. 9d. to 8s. Manufacturing and coking coals are quiet; and sales for next year are on a lower basis. In the gas coal trade there is a full demand; but it is well met, and is scarcely as large as was experienced a year ago, when the companies had much smaller stocks than they now have. Prices of gas coals are from 13s. to 13s. 6d. per ton f.o.b.; so that the fall is rather marked from the rates at which some of the current contracts were settled, about the middle of this year. Best Durham coke for blast-furnaces is in larger demand; the need of stocks for the holidays being felt. For export, business is slow at about 22s. to 24s. per ton f.o.b. Gas coke is in fuller production, and so far the quotation is 24s. per ton f.o.b.; but it seems to be undecided yet what next year's contracts may be.

Scotch Coal Trade.—The coal trade is in a parlous condition. With the prospect of holidays at this season the immediate demand is small, and forward inquiries are scarcely in existence. Prices are therefore still receding. The quotations are: Main, 11s. to 11s. 3d. per ton f.o.b. Glasgow, ell 12s. to 12s. 9d., and splint 12s. 6d. to 13s. The shipments for the week amounted to 183,705 tons—a decrease upon the previous week of 14,880 tons, but an increase upon the corresponding week of last year of 1608 tons. For the year to date, the total shipments have been 10,557,822 tons—an increase of 1,957,688 tons.

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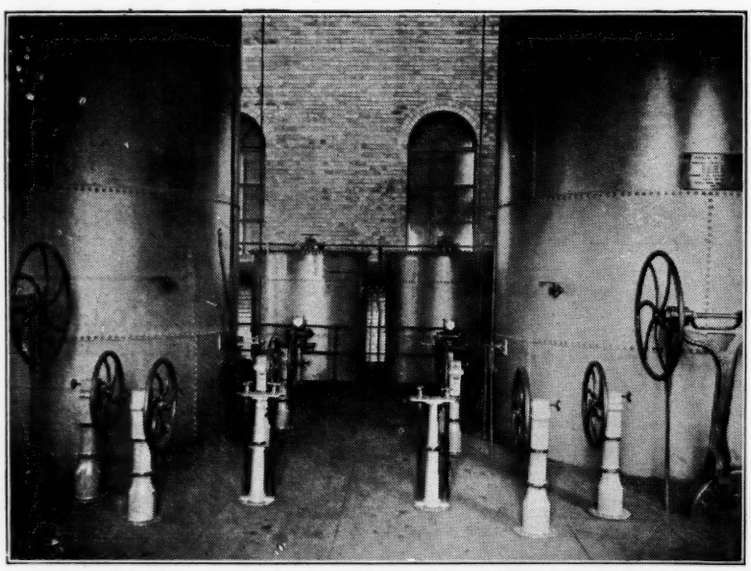

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Working Floor of Generator House. One Quarter Section of Birmingham Plant, Windsor Street Station.
The Maximum Daily Capacity of the Birmingham Corporation's Plant, which was erected by this Company, is 10 MILLION CUBIC FEET.

Dover Gas and Electricity Companies and the Corporation.—We hear on good authority that the Dover Gas Company have removed from their Bill the clause to enable them to purchase the undertaking of the Dover Electricity Supply Company; and, as a consequence, the Corporation have withdrawn their Bill to acquire the Gas and Electricity Companies. Matters are therefore left precisely as they were.

Fatal Gas Explosion at Malvern.—An inquest was held last Tuesday on the body of Mrs. E. A. Joshua, of Malvern, who met with her death through an explosion of gas on the 13th inst. Dr. and Mrs. Joshua entered a new house on the 4th inst. In the breakfast room an old gas chandelier was fitted; and the gas-fitter had pronounced it safe. Dr. Joshua left it as usual with the bye-pass of the burner lighted and the pendant pulled down on the 12th inst., and went to bed at 11.30 p.m. An escape of gas was noticed next morning; and the servants threw up the windows. The bye-pass was still alight and the pendant pulled down. Mrs. Joshua, entering the room, pushed up the gas-pendant, when an explosion occurred, and she rushed out of the room in flames. She was severely burned, and died on Saturday evening. No blame was attachable to anyone. The Jury returned a verdict accordingly.

Gas v. Electric Light at Wakefield.—A little breeze occurred over the question of the public lighting of certain streets in Wakefield and the district of Alverthorpe at the last meeting of the Wakefield City Council. The Street Lighting Committee had received an offer from the Directors of the Gas Company, expressing their willingness to co-operate with the Committee in improving the lighting of the city by the introduction of Welsbach burners. They offered to alter the existing lanterns, &c., for the sum of £1 1s. 4d. per lamp. In the Alverthorpe area they would provide and fix them complete for £1 14s. 7d. each. Without prejudice, they would fix lamp-columns free of cost in streets where mains were already laid, provided the Corporation would undertake to use them for not less than five years. Mr. Ramsden, the Chairman of the Committee, moved that the minutes be approved, and that the offers of the Company be accepted. He remarked that in many large towns and cities incandescent burners had been adopted in preference to electric lighting, which had not been found so satisfactory as it was thought to be when first introduced. Mr. Wigham, the Chairman of the Electric Lighting Committee, complained that in this matter of improving the public lighting of the town his Committee had not been considered in any way. He was prepared to admit that up to now the arc lamps in the city had not covered themselves with glory. Still, during the time the undertaking had been running, the Committee had done all they could in the way of experimenting to find out which were the best systems to adopt to secure a type of arc lamp which would be a credit to Wakefield. They were anxious to make the electric light works a success; and he therefore moved, as an amendment, that the minutes be referred back for further consideration, so that the Electric Lighting Committee might have an opportunity of tendering. After some discussion, in which the electric lighting of the city was pronounced a failure, Mr. Ramsden consented to accept the amendment, which was eventually submitted as the substantive resolution and carried.

Carmarthen Public Lighting.—At the last meeting of the Carmarthen Town Council, the Lighting Committee presented a report in which they submitted a new scheme of public lighting, under which 48 lamps would be kept burning all night, as at present, but 184 would be extinguished. The change would, it was stated, result in a reduction of £207 in the annual gas bill; and, after deducting 12s. a week each for two men to extinguish the lamps, the net saving would be £144 12s. Mr. Spurrell moved that the scheme be tried for a year; remarking that it was a great waste of gas to keep it burning all night. Mr. Lloyd expressed disapproval of 80 per cent. of the public lamps being extinguished at midnight. He thought the Council ought to consider the question of convenience before that of expense. He moved, as an amendment, that only half the lights be dispensed with at midnight. After some discussion, the motion was carried.

A Southport Lesson on How to Obtain New Business.—The ratepayers of Banks, which is a village within the Southport gas-supply area, have been considering the question of adopting a present-day system of illumination; and they have been very much aided in coming to a decision by the politic steps taken by Mr. Trounson, the Chairman of the Corporation Gas Committee, and Mr. John Booth, the Engineer. A meeting of ratepayers was called to consider the question; but before the special business of the meeting commenced, Mr. Trounson and Mr. Booth occupied the platform, and both told their audience, in a short time and in an exceedingly entertaining manner, more about gas and its uses than those present had possibly heard or learnt in the whole of their lives before. Thus primed, the Banks ratepayers settled down to discuss the written conditions on which the Corporation Gas Committee had offered to supply the district, both privately and publicly; and 37 out of 43 ratepayers had no difficulty in coming to the conclusion that the "comfort, convenience, safety, and moral welfare" of the village would be improved by the introduction of gas lighting.

Awards at the Lighting Industries Exhibition at Vienna.—The list of awards to exhibitors at this exhibition, of which particulars have already been given in the "JOURNAL" (*ante*, p. 889), has now been published. We do not observe the name of any English firm in the long list of winners of distinctions; but it seems highly probable that no English firms were exhibiting. In the list of gold medallists, we notice the following names of firms, &c., connected with the gas industry: The Aërogen Gas Company of Vienna, for Aërogen gas plant; Brix, Kempler, and Co., of Vienna, for their "Millenium" light; the German Continental Gas Company, of Dessau, for the "Industria" lamp, and cooking and heating apparatus; S. Elster, of Vienna, for gas-meters, photometers, and cooking apparatus; Michaelis and Eichstädt, of Vienna, for gas cooking and lighting apparatus; Julius Pintsch, of Vienna, for gas-meters, prepayment meters, and lighting appliances; the "Sirius" air-gas apparatus; and the International Water-Gas Company, of Vienna, for Dr. Strache's patent water-gas plant and purifying scheme. Many of the firms named as of Vienna will be recognized as having their chief offices and works elsewhere. There were 17 gold medals, 16 silver medals, and 12 bronze medals awarded.

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Softening the Wilmslow Water Supply.—It has been decided to spend £4200 in the erection of new plant at the Wilmslow Water-Works. Many serious complaints have been received from all parts of the Wilmslow and Alderley Edge districts with regard to the extraordinary hardness of the water; and the authorities now propose to adopt the Archbitt-Deeley softening process.

Fatality at a Gas-Works.—Thomas Cook (aged 50), a Rawtenstall farmer, was killed on Monday last week by an explosion in a tar and liquor tank at the works of the Rossendale Union Gas Company, Cloughfold. Deceased went to the works with a horse and cart for a load of coke; and while he was there, the explosion occurred. It is supposed that he was standing on the cover of the tank, as his lifeless body was afterwards found in it. No one saw the explosion. At the inquest, a verdict of "Accidental death" was returned.

Wells Water Supply.—The campaign in connection with the poll of the city on the question of the purchase of the Wells Water Company's undertaking by the Corporation was conducted with much vigour. The result was that 650 votes were cast in favour of the scheme and 348 against it; giving a majority of 302 in favour. The Town Council have held a special meeting to advance their parliamentary procedure, at which a suggestion was thrown out that the Company should be again approached with the view of endeavouring to arrive at an amicable understanding, and so carry the Bill through unopposed. The question, however, was allowed to stand over for the present.

Reduction in Price by the Wandsworth and Putney Gas Company.—Our readers may remember that the above-named Company were among the last to raise their charge for gas in consequence of the great advance in the price of coal some months since. This evidence of the Company's desire to relieve the consumers as much as possible from the burden which extraordinary circumstances had placed upon them has now been further borne out by an announcement by the Secretary that, now that the coal market is easier, a reduction of 2d. per 1000 cubic feet (2s. 6d. to 2s. 4d.) is to be made after the turn of the quarter.

Compensation for Damage to Gas-Mains at Carmarthen.—As the result of the operations of the Carmarthen Corporation upon the roads of the town, much damage has been done from time to time to the mains of the Gas Company, with consequent loss of gas; and some eighteen months ago the matter came before the Town Council, and a Committee was eventually appointed to deal with it. As the result of a conference between them and the Directors of the Company, the Corporation have agreed to pay £50 in full satisfaction of all claims for broken pipes and loss of gas up to the end of the year 1899. The Committee recommended that in future the amount of damage should be assessed at the time of its occurrence by the Manager of the Company and the Surveyor of the Corporation; that the cost of renewing the pipes broken by the Corporation should be equally divided between them and the Company; that the Corporation should pay the actual estimated cost of the gas lost through the leakages; and that the Corporation should accept the Company's offer to defray half the cost of laying down the main in St. David's Street. These recommendations were agreed to.

The Felixstowe Water Company have decided to raise £3500 of additional capital in £10 shares.

The ratepayers of Birkdale last Thursday consented to the promotion of the Bill by which it is proposed to form a Joint Water Board for Southport and the surrounding district.

The Elland Gas Company have placed with Messrs. Jonas Drake and Son, of Ovenden, Halifax, an order for the erection of an inclined retort-bench of six arches, with all the necessary elevating and conveying machinery.

The Washington Bureau of Foreign Commerce has received a letter from Mr. J. P. Spanier, of No. 160, Corso Umberto I°, Rome, asking to be put in communication with responsible firms who can offer full cargoes of pitch, to be used in the manufacturing of patent fuel. Considerable business, he says, can be transacted if connections are made with the proper party.

The fact that the South Yorkshire coalowners have decided to offer railway companies coal at 14s. a ton—this being a reduction of 2s. per ton upon the average price of the contracts at present running and of 1s. upon the price demanded three weeks ago—is regarded by the "Financial News" as showing plainly that the bottom is out of the coal boom. Our contemporary points out that "Mr. Livesey's advice and prophecies have proved right, after all."

Our readers will see, by an announcement which appears elsewhere, that the Directors of the Gaslight and Coke Company have instructed Mr. Alfred Richards to offer for sale by auction, at the Mart, Tokenhouse Yard, on the 16th prox., £163,190 of ordinary stock of the Company. It is issued under the provisions of the Company's Act of 1898, and ranks for a standard dividend of 4 per cent. per annum, subject to the sliding-scale, under which, at the present price of gas, the authorized rate of dividend payable is £4 8s. per cent. per annum.

The death of Alderman A. Sinclair, of St. Helens, has brought strikingly before the ratepayers the fact that their water undertaking has enormously expanded during the last half century. Away back in the early fifties, Alderman Sinclair was a member of the old Board of Commissioners, and was one of the Committee who negotiated and signed the agreement for the purchase of the water undertaking for a yearly rental of £610. By the purchase, the Commissioners acquired the monopoly of the water supply in St. Helens; and since that time the sum of £160,000 has been expended on works extensions.

Our readers are aware that the Elland Gas Company have given notice of their intention to promote a Bill to enable them to raise additional capital, undertake the sale and hire of gas-fittings, gas-engines, &c., and obtain further powers in respect of the price and supply of gas. Under these circumstances, it is thought that the present is an opportune time to discuss the desirability of securing the gas-works for the benefit of the various districts interested; and, with the idea of coming to some basis of common action, the Elland District Council have decided to ask the Greetland and Stainland Councils to meet them in conference to discuss the whole question.

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[For Illustrated Advertisement, see Dec. 4, p. 1426.]

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Applications, endorsed "Gas-Works Manager," stating Age, present and former Occupation, Salary required, and accompanied by *copi s* only of not more than three Testimonials of recent date, on Forms which will be furnished by the undersigned on receipt of a stamped addressed foolscap envelope, to be sent to me on or before Tuesday, the 1st of January, 1901.
Canvassing will disqualify.
FREDK. S. HEX,
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Municipal Offices, Town Hall,
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By order,
JNO. MILLS,
Town Clerk.
Town Hall, Chorley,
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NOTICE.

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After entailing considerable expense upon themselves and upon us, Messrs. Meters Limited had to ABANDON THE ACTION, leaving us in possession of the field, and they have now ended the matter by PAYING OUR JUDICIAL EXPENSES.
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One Set of Four 6-ft. PURIFIERS.
One " Four 8-ft. "
One " Four 12-ft. "
Four 6-inch ANNULAR CONDENSERS.
Six 16-inch " "
TOWER SCRUBBERS, 3-ft., 4-ft., 5-ft. 6-ft., and 7-ft. diameter.
EXHAUSTERS, 2000 to 60,000 Cubic Feet per hour.
WASHERS by Holmes, Clapham, Livesey, & Cripps.
STATION METERS and GOVERNORS, Several Sizes.
GASHOLDERS, 50 ft., 40 ft., 30 ft., and smaller.
RETORT IRONWORK, MODERN HYDRAULICS.
Telegrams: "BLAKELEY, THORNHILL LEES."

HAWORTH URBAN DISTRICT COUNCIL.

TENDERS are invited for the purchase of the Council's surplus TAR and LIQUOR for the Year ending Dec. 31, 1901, delivered on Rails at Haworth Station.
Tenders to be sent to me not later than Dec. 27, 1900.
WM. ROBERTSHAW,
Clerk.
Burlington Buildings,
North Street, Keighley.

WORTHING GAS COMPANY.

THE Company are prepared to receive TENDERS for 350 ORDINARY SHARES of £10 each, ranking for a Standard Dividend of 7 per cent. per annum, subject to the Sliding-Scale.
Minimum Price £15 per Share.
Tenders must be sent in not later than Eleven a.m. Friday, the 18th of January, 1901.
Particulars, Conditions, and Form of Tender obtainable on application to:—
W. FRED VERRALL,
Secretary to the Company.
55, Chapel Road, Worthing.

CLACTON URBAN DISTRICT COUNCIL.

TAR.

THE above Council are prepared to receive TENDERS for the purchase of the surplus TAR produced at their Gas-Works for the ensuing Twelve Months.
Particulars may be obtained from Mr. Sidney Francis, the Council's Engineer, Town Hall, Clacton-on-Sea.
Sealed Tenders, endorsed "Tender for Tar," to be delivered to the undersigned not later than Four o'clock on Monday, the 7th of January next.
The Council do not bind themselves to accept the highest or any Tender.
GEO. T. LEWIS,
Clerk to the Council.
Town Hall Buildings,
Clacton-on-Sea, Dec. 20, 1900.

CLACTON URBAN DISTRICT COUNCIL.

GAS-METERS.

THE above Council are prepared to receive TENDERS for the supply of PREPAYMENT and ORDINARY DRY GAS-METERS.
Full Particulars may be obtained upon application to Mr. Sidney Francis, the Council's Engineer, Town Hall, Clacton-on-Sea.
Tenders, sealed and endorsed "Tender for Meters," to be delivered to the undersigned not later than Four o'clock on Monday, the 7th of January next.
The Council do not bind themselves to accept the lowest or any Tender.
GEO. T. LEWIS,
Clerk to the Council.
Town Hall Buildings,
Clacton-on-Sea, Dec. 20, 1900.

SUTTON GAS COMPANY (SURREY).

THE Directors of the Sutton Gas Company invite TENDERS for the construction and erection of the under-mentioned BUILDINGS and IRONWORK, in accordance with Drawings and Specifications prepared by their Engineer Mr. Geo. Mead Robins, Sutton.
CONTRACT No. 1—RETORT-HOUSE BUILDING, 150 ft. long, by 62 ft. wide, and Concrete Foundations, &c.
CONTRACT No. 2—STEEL ROOF, 62 ft. Span, for Retort-House, together with Cast-Iron Columns, Steel Girders and Cast-Iron Stage-Floor Plates, and all the Ironwork and Fittings (exclusive of Mouthpieces) for Two Double Settings of Retorts.
CONTRACT No. 3—BUILDING RETORT-STACK of Seven Arches and Two through Regenerative Settings, each consisting of seven 21 in. by 15 in. ⏢ Retorts.
Drawings and Specifications can be seen at the Offices of the Company on or after the 24th inst., or copies of same can be obtained from the undersigned on payment of the sum of £2 2s. in respect of each Contract, which will be refunded upon receipt of a *bonâ-fide* Tender, accompanied by the copies of Drawings and Specifications.
Sealed Tenders, endorsed "Contract No. 1, 2, or 3," respectively, to be delivered to the undersigned on or before Monday, the 14th of January, 1901.
By order of the Board,
(Signed) GEO. MEAD ROBINS, M.Inst.M.E.
Engineer and Secretary.
Dec. 22, 1900.

EDINBURGH AND LEITH CORPORATIONS' GAS COMMISSIONERS.

GAS-WORKS PLANT AND MACHINERY.

THE Commissioners are prepared to receive TENDERS for the supply of all or any of the following PLANT and APPLIANCES, delivered and erected at their Granton Works, from Contractors experienced in the construction of same. The whole of the Work is to be carried out in conformity with the General Conditions and Clauses of the Commissioners' Specification, and is to be delivered and completed and put to work on or before the 31st of March, 1902.
1. STEAM BOILERS AND FITTINGS of either the Lancashire or Tubular Type.
2. GAS EXHAUSTERS and ENGINES.
3. WATER-TUBE CONDENSERS for Steam.
4. WATER-TUBE CONDENSERS for Gas.
5. PELOUZE & AUDOUIN TAR SEPARATOR.
6. HYDRAULIC PUMPING MACHINERY, ACCUMULATORS, and CAPSTANS.
7. WASHER-SCRUBBERS of the Rotary Type for Coal Gas.
8. WASHER-SCRUBBERS and APPLIANCES for the Extraction of Cyanide Compounds.
9. PURIFYING PLANT.
10. PURIFYING PLANT HOUSE (Iron Structure).
11. STATION METERS.

Specification and Form of Tender may be obtained on application to Mr. W. R. Herring, Chief Engineer and Manager, Gas-Works, New Street, Edinburgh.
Tenders are to be delivered to the undersigned at or before Ten a.m., on the 11th day of February, 1901, sealed and endorsed, as directed under each portion of the Plant.
The Commissioners do not bind themselves to accept the lowest or any Offer.
JAMES M'G. JACK,
Clerk.
25, Waterloo Place, Edinburgh,
Nov. 30, 1900.

ABINGDON GAS-WORKS.

TENDERS are invited for the purchase of the surplus TAR produced at the above Works or One Year from the 1st of January, 1901.

Tenders, stating Price per Ton loaded into Tank-Waggons at the Company's Siding, to be sent to the undersigned not later than Jan. 7, 1901.

S. CROSSLAND,
Manager and Secretary.

Gas Company's Offices, Vineyard,
Abingdon-on-Thames, Dec. 20, 1900.

THE Directors of the Worksop Gas Company invite TENDERS for the purchase of the surplus TAR and the AMMONIACAL LIQUOR made at their Works from the 1st of January to the 31st of December, 1901.

Tenders for Tar to state Price per Ton delivered into Purchaser's Tanks at the Worksop Railway Station.

Tenders for Liquor to state Price per Ton as tested by No. 1 Twaddel Hydrometer, delivered into Boats near the Company's Works, or Price per Ton delivered into Purchaser's Tanks at the Railway Station.

The Directors do not bind themselves to accept the highest or any Tender.

Tenders to be sent in by the 29th of December.

Worksop, Dec. 12, 1900.

ROCHDALE CORPORATION.

TO RETORT MAKERS AND OTHERS.

THE Gas Committee of the above Corporation invite TENDERS for the supply of such quantities of RETORTS and other FIRE-CLAY GOODS as may be required during the Year ending the 31st of December, 1901.

Form of Tender and any further Information may be obtained on application to Mr. T. Banbury Ball, the Manager at the Gas-Works.

Tenders, endorsed "Fire-Clay Goods," must be sent to me not later than noon on Wednesday, the 2nd of January, 1901.

Contractors who intend to sublet part of their Contracts must forward with their original Tenders a list of the names of their Sub-Contractors.

By order,
JAMES LEACH,
Town Clerk.

Town Hall, Rochdale,
Dec. 22, 1900.

SALES BY AUCTION OF GAS AND WATER STOCKS AND SHARES.

MR. ALFRED RICHARDS begs to notify that his AUCTIONS of STOCKS and SHARES in London, Suburban, and Provincial Gas and Water Companies are held PERIODICALLY, at the Mart, Tokenhouse Yard, E.C.

He also undertakes the issuing by AUCTION of GAS and WATER STOCKS and SHARES under Parliamentary Powers.

Terms for issuing such Capital, and also for including Gas and Water Stocks and Shares in these periodical Sales, can be obtained on application at Mr. ALFRED RICHARDS' OFFICES, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
TOTTENHAM AND EDMONTON GASLIGHT AND COKE COMPANY.

NEW ISSUE OF £10,000 FOUR PER CENT. PERPETUAL DEBENTURE STOCK.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, Jan. 8, 1901, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
ILFORD GAS COMPANY.

£7500 ORDINARY STOCK.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, Jan. 8, 1901, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
BRIGHTON AND HOVE GENERAL GAS COMPANY.

MR. ALFRED RICHARDS will Sell by AUCTION at the Mart, E.C., on Monday, Jan. 14, at Two o'clock, in Lots,

£20,000 "A" ORDINARY STOCK,

Ranking for a Standard Dividend of 7 per cent., subject to the Sliding-Scale; the last Dividend on the Company's "A" Stock having been at this rate.

Particulars of the SECRETARY of the Company, 5, GT. WINCHESTER STREET, E.C., and 77, West Street, BRIGHTON; and of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
GASLIGHT AND COKE COMPANY.

ISSUE OF £163,190 ORDINARY STOCK.

MR. ALFRED RICHARDS will Sell by AUCTION, at the Mart, Tokenhouse Yard, London, E.C., on Wednesday, Jan. 16, 1901, at Two o'clock precisely, in Lots.

£163,190 ORDINARY STOCK
OF THE
GASLIGHT AND COKE COMPANY.

This Stock, which is issued under the provisions of the Gaslight and Coke Company's Act of 1898, ranks for a Standard Dividend of 4 per cent. per annum, subject to the Sliding-Scale, under which, at the present price of Gas, the authorized rate of Dividend payable is £4 8s. per cent. per annum.

Particulars may be obtained at the OFFICES OF THE COMPANY, in Horseferry Road, Westminster, S.W.; and of the Auctioneer, 18, Finsbury Circus, LONDON, E.C.

PORTLAND URBAN DISTRICT COUNCIL.

(GAS DEPARTMENT.)

THE Gas Committee of the above Council are prepared to receive TENDERS for the purchase of the surplus TAR and AMMONIACAL LIQUOR, produced at their Works, for a period of One Year, from Jan. 1 to Dec. 31, 1901, delivered into Contractors' Tanks on the Great Western Railway Sidings, Portland Station.

Tenders to be sent in to the undersigned not later than Dec. 31, 1900.

JNO. O. WHITAKER,
Manager.

Gas-Works, Portland.

SOUTH METROPOLITAN GAS COMPANY.

SALE BY TENDER OF £80,000 THREE PER CENT. PERPETUAL DEBENTURE STOCK.

MINIMUM PRICE, £94 PER CENT.

NOTICE is Hereby Given, that it is the intention of the Directors of this Company to SELL BY TENDER £80,000 THREE PER CENT. PERPETUAL DEBENTURE STOCK, in accordance with the Provisions of the South Metropolitan Gas Acts, 1882 and 1896.

Particulars of same, with Form of Tender, can be obtained at this Office on application to the undersigned, and Tenders must be sent in on or before Tuesday, the 22nd day of January, 1901.

The Stock will be allotted to the highest bidders, but no Tender will be accepted at a lower price than at the rate of £94 money for each £100 Debenture Stock.

By order,
FRANK BUSH,
Secretary.

Offices: 709A, Old Kent Road,
London, S.E., Dec. 22, 1900.

Foolscap 4to, pp. 535, with 239 Illustrations and Steel-Plate Engraving (as Frontispiece) of WILLIAM MURDOCH, *Inventor of Gas Lighting. Morocco Gilt, 21s.; Roan Gilt, 18s.*

THE SIXTH (AND CENTENARY) EDITION
OF THE
HANDBOOK
FOR
GAS ENGINEERS AND MANAGERS.

By THOMAS NEWBIGGING, M.Inst.C.E.

LONDON:
WALTER KING, 11, BOLT COURT, FLEET ST.

HARDMAN & HOLDEN, LD.

ESTABLISHED 1820.

SULPHURIC ACID.

GUARANTEED absolutely free from Arsenic and of excellent Purity. Specially prepared for Sulphate of Ammonia Manufacturers.

Works: BLACKBURN; Miles Platting and Clayton, MANCHESTER.

Head Office: Miles Platting, MANCHESTER.

Inquiries Solicited.

BOLDON GAS COALS.

Yield of Gas per Ton.	10,500	Cubic Feet.
Illuminating Power	16·9	Candles.
Coke	66·7	Coke.
Sulphur	0·86	Sulphur.
Ash	2·04	Ash.

As per Analysis by
Mr. JOHN PATTINSON, F.I.C., F.C.S.

For Prices, &c., apply to
W. H. PARKINSON,
THE HARTON COAL CO., LTD.,
NEWCASTLE-ON-TYNE.

Telegraphic Address: "PARKINSON, NEWCASTLE."

COKE-BREAKERS,

PRICES REDUCED.

(THOMAS & SOMERVILLE'S PATENT)

With Elevators and Conveyors worked by Steam or Gas Engine.

GEORGE WALLER & CO.,
165, QUEEN VICTORIA STREET, E.C.;
And at STROUD, GLOUCESTERSHIRE.

HYDRAULIC BLOWER

For blowing Air into Gas Purifiers for the purpose of

REVIVIFYING THE FOULED OXIDE.

Full Particulars on application.

LUXWERKE LUDWIGSHAFEN AM RHEIN.

THOMAS TURTON AND SONS, LIMITED,

SHEAF WORKS, SHEFFIELD,

MANUFACTURERS OF

FILES OF BEST QUALITY

FOR ENGINEERS.

STEEL OF ALL DESCRIPTIONS.

SCREW STOCKS, TAPS AND DIES,
SPANNERS, RATCHET BRACES, LIFTING JACKS
ANVILS, VICES,
AND ENGINEERS' TOOLS GENERALLY.

LONDON OFFICE:
90, CANNON STREET, E.C.

LONDONDERRY GAS COALS

FROM THE

LONDONDERRY COLLIERIES,

COUNTY OF DURHAM.

Available Output up to 5000 Tons per day.
Yield of Gas 11,000 cubic feet per Ton of Coal as per Analysis by
Mr. John Pattinson, F.C.S., F.I.S.

FOR PRICES AND PARTICULARS, APPLY TO

S. J. DITCHFIELD,
SEAHAM HARBOUR,
COUNTY OF DURHAM.

WELDON MUD

FOR

GAS PURIFICATION.

For use in the

RECOVERY OF SULPHUR,

ALSO

Removal of last Traces of SULPHURETTED HYDROGEN in catch position.

Full Particulars on application to the Patentees:

GAS DESULPHURIZATION CO.,
— *LIMITED,* —
1, FENCHURCH AVENUE, LONDON, E.C.

THORNLEY GAS COALS

WORKED BY THE

WEARDALE IRON & COAL Co., Ld.

OUT OF THEIR

THORNLEY AND WHEATLEY HILL COLLIERIES.

Analysis made by

Messrs. J. & H. S. PATTINSON.

Yield of Gas per Ton . .	10,500 Cub. Ft.
Illuminating Power . . .	16·9 Candles.
Coke (of good quality) . .	67·5 per Cent.
Sulphur	0·58 „
Ash	2·73 „

For Price, &c., apply to the

WEARDALE IRON & COAL Co., Ld.

QUAYSIDE, NEWCASTLE-ON-TYNE.

HOLMSIDE

GAS COALS.

Present Daily Produce over 5000 Tons.

Latest Analysis—By CHARLES PHILLIPS, Gas Examiner to Rotherham Corporation

Yield of Gas per Ton . . . 11,205 Cubic Feet.
Illuminating Power $16\frac{7}{10}$ Stand. Sperm Candl.
Coke (of good & pure quality) $13\frac{3}{4}$ Cwt. per Ton.
Sulphur . . . . . A little over 1 per Cent.
Ash . . . . . Under 1 per Cent.
Tar . . . . . 163 lbs. (Avoir.) per Ton.
Ammoniacal Liquor 103 lbs. (Avoir.) per Ton.

HOLMSIDE GAS COALS are supplied to the largest Gas Companies in England and on the European Continent; London alone consuming about half the produce.

SOUTH MOOR

PELTON GAS COALS.

Present Daily Produce available 3000 Tons.

Of equal quality to the "Holmside" Coal, and also very largely used by many Gas Companies at Home and Abroad.

Both descriptions are shipped at Tyne Docks, and Dunston Staiths, River Tyne, also at North and South Docks, Sunderland.

These Coals may be bought through the Principal Merchants in England, or direct from

MR. MARK ARCHER,

HOLMSIDE & SOUTH MOOR OFFICES,

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NITRATE of Thorium and Cerium.

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Meters, Fire-Clay Goods, Oxide of Iron, and all other Gas Apparatus. Retort Carbon purchased.

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ALFRETON IRON-WORKS, DERBYSHIRE,

AND

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Manufacture and keep in Stock at their Works (also large stock in London)

PIPES and CONNECTIONS, $1\frac{1}{2}$ to 48 inches in diameter, and make and erect to order RETORTS, PURIFIERS and TANKS, with or without planed joints, COLUMNS, GIRDERS, SPECIAL CASTINGS, &c., required by Gas, Water, Railway, Telegraph, Chemical, Colliery, and other Companies.

NOTE.—Makers of HORSLEY'S PATENT SYPHONS. These are cast in one piece, without Chaplets; doing away with Bolts, Nuts and Covers, and rendering Leakage impossible.

GAS-FITTINGS.

BURNERS

Welsbach Pattern

per 7/6 Doz.

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INCANDESCENT

NEWBATTLE CANNEL.

Highest Results in Gas, & Excellent Coke.

QUOTATIONS ON APPLICATION TO

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Awarded HIGHEST MEDAL and DIPLOMA at the Newcastle-on-Tyne Royal Mining and Industrial Exhibition, 1887, for

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TYNE

BOGHEAD CANNEL.

Yield of Gas per ton	13,155 cub. ft.
Illuminating Power	38·22 candles.
Coke per ton	1,301·88 lbs.

EAST PONTOP GAS COAL.

Yield of Gas per ton	10,500 cub. ft.
Illuminating Power	17·8 candles.
Coke	70 per cent.

SOUTH PELAW MAIN GAS COAL.

Yield of Gas per ton	10,500 cub. ft.
Illuminating Power	16·3 candles.
Coke	73·1 per cent.

For Prices and complete Analysis, apply to

THOS. W. DANCE, SON, & HUNTER,

COAL OWNERS, NEWCASTLE-ON-TYNE

OR

E. FOSTER & CO.,

21, JOHN STREET, ADELPHI, LONDON, W.C.

HARRIS & PEARSON,

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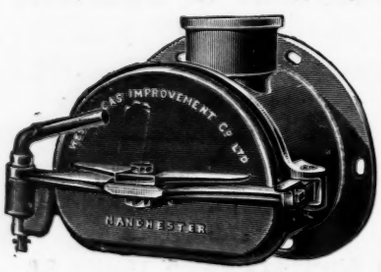
FIRE-CLAY GAS-RETORTS, FIRE-BRICKS, LUMPS, & TILES of Every Description.

GLAZED BRICKS AND PORCELAIN BATHS.

WEST'S GAS IMPROVEMENT COMPANY, LTD.

ALBION IRON-WORKS, MILES PLATTING, MANCHESTER;

AND 104, QUEEN VICTORIA STREET, LONDON, E.C.



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WEST'S PATENT REGENERATOR SETTINGS.

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RETORT MOUTHPIECES WITH SELF-SEALING LIDS.

UNEQUALLED.

Gas Companies are solicited to try Samples of the

MIRFIELD

BLACK BED GAS COAL.

Prices and Analysis on application.

MIRFIELD (GAS-COAL) COLLIERY COMPY.

RAVENSTHORPE, NEAR DEWSBURY.

DISPENSE WITH CANNEL COAL

and

INCREASE YOUR ILLUMINATING POWER

by using the

WHESSOE-MUNICH BENZOL CARBURETTER

The Cheapest and Best in the Market.

The Managers of Tynemouth, Middlesbrough, and Darlington Gas-Works are much pleased with it, and would not be without it.

Apply to the Sole Makers:

THE WHESSOE FOUNDRY COMPANY, LIMITED, DARLINGTON.

HEATHCOTE GAS COAL.

Rich in Illuminating Power and Yield of Gas.

Above the Average in Weight and Quality of Coke.

Maintains a High Standard in Residuals.

THE GRASSMOOR CO., LD.

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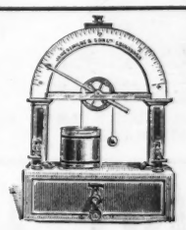

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— LIMITED. —

Specialities:

TRANSMISSION OF POWER.

Rope and Belt Pulleys,
Spur and Bevel Wheels,
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Pedestals, and Fixings.

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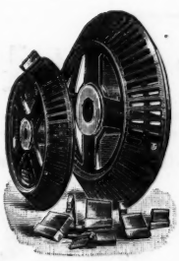

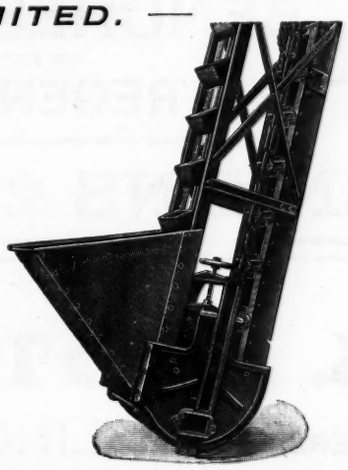

Specialities:

TRANSMISSION OF MATERIALS.

Conveyors,
Elevators,
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LONDON, E.C.

JONAS DRAKE & SON,

OVENDEN, HALIFAX,

HAVE ERECTED 500 OF THEIR PATENT

TUBE REGENERATOR

FURNACES DURING THE LAST 4 YEARS.

ESTIMATES ON APPLICATION.

Telephone No. 43. HALIFAX EXCHANGE.

LONDON OFFICE: 34, VICTORIA ST., S.W.

Telegraphic Address: "DRAKESON HALIFAX."

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Telegrams: "EVANS, WOLVERHAMPTON." PLEASE APPLY FOR CATALOGUE No. 8. National Telephone No. 7039.

12,000 PUMPS IN STOCK AND PROGRESS.

TRADE MARK.

NO TAPPETS.

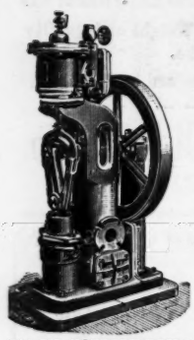

Fig. 705. "SINGLE RAM" STEAM-PUMP.

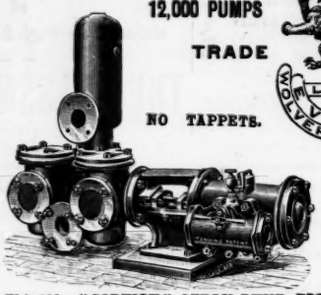

Fig. 598. "CORNISH" STEAM-PUMP FOR BOILER FEEDING, &c.

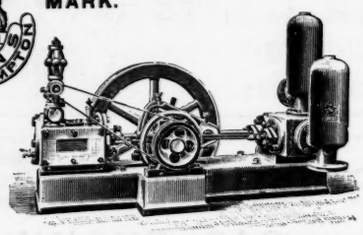

Fig. 688. "RELIABLE" STEAM-PUMP FOR TAR AND THICK FLUIDS.

Fig. 712. "DOUBLE-RAM" STEAM-PUMP.

INCLINED RETORTS.

HORIZONTAL RETORTS.

RETORT BENCHES AND SETTINGS, WITH GENERATOR OR REGENERATOR FURNACES.

W. J. JENKINS & CO., Ltd., RETFORD.

Telephone No. 103. Telegraphic Address: "ELEVATOR, HASLINGDEN."

S. S. STOTT & CO.,

ENGINEERS, HASLINGDEN, NR. MANCHESTER.

COAL AND COKE ELEVATORS & CONVEYORS.

COAL AND COKE STORAGE PLANTS.

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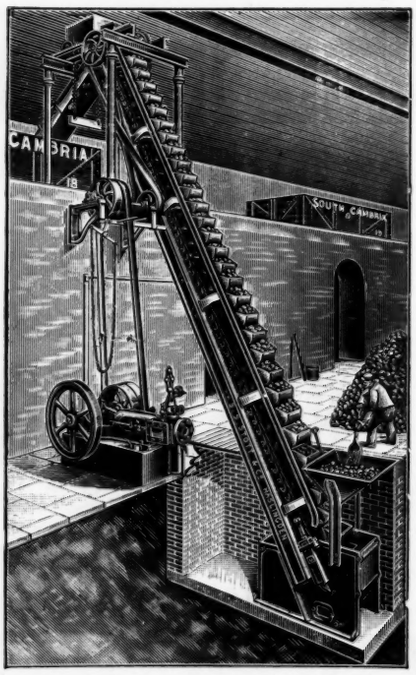
WHARF ELEVATORS FOR UNLOADING BARGES.

ELEVATORS & CONVEYORS for BOILER-HOUSES.

STAMPED AND RIVETED STEEL ELEVATOR BUCKETS.

DETACHABLE CHAINS AND SPROCKET WHEELS.



LIME AND OXIDE ELEVATORS & CONVEYORS.

HIGH-CLASS STEAM-ENGINES up to 1000-Horse Power.

PUMPS, HORIZONTAL AND VERTICAL, SINGLE, DOUBLE, or THREE-THROW, for WATER-WORKS, &c.

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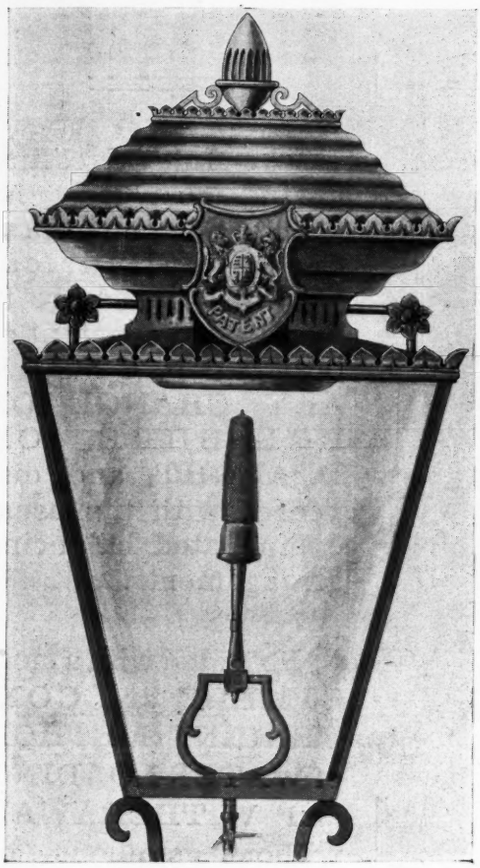

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No Complex Mechanism.

"Power" Free of Cost.

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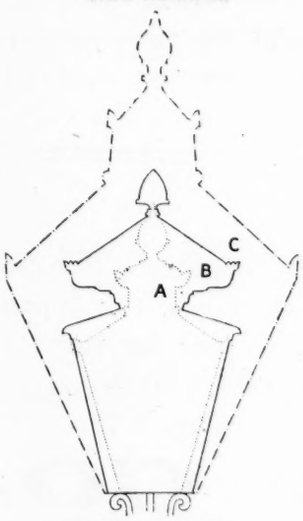
The **SCOTT-SNELL LAMP** may be set to give any pressure from **4 inches to 36 inches of Water; 8 inches to 10 inches is usually preferred.**

300-*CANDLE POWER OBTAINED FROM A SINGLE BURNER.*

Lanterns supplied with Single, Duplex, or Cluster of Burners.



SCALE DIAGRAM.
A. Ordinary 16-inch Street Lamp.
B. Scott-Snell Self-Intensifying Lamp.
C. Ordinary Refuge Lamp.

HIGH-PRESSURE LIGHTING HAS COME TO STAY.

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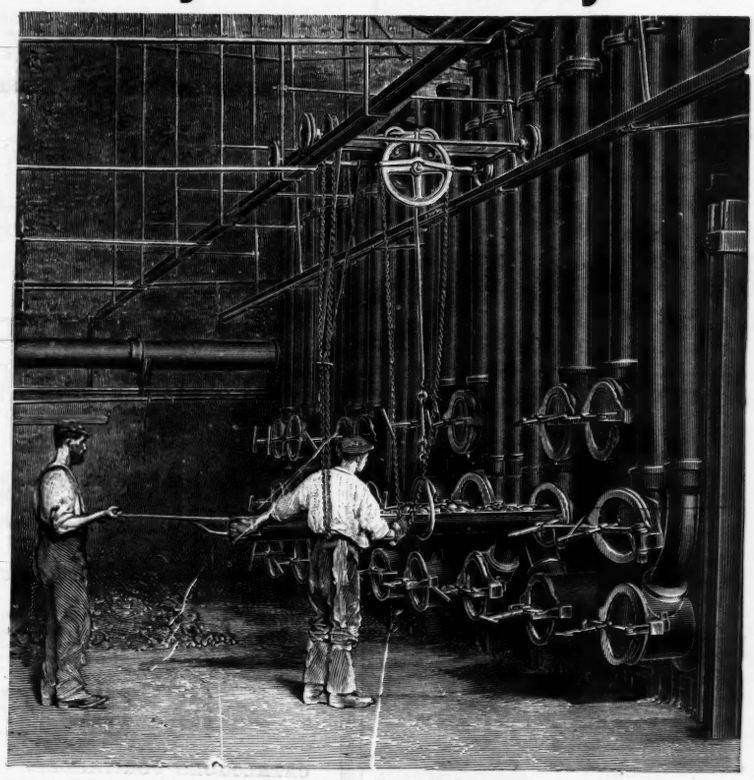

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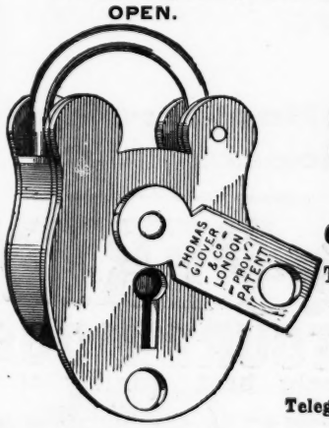

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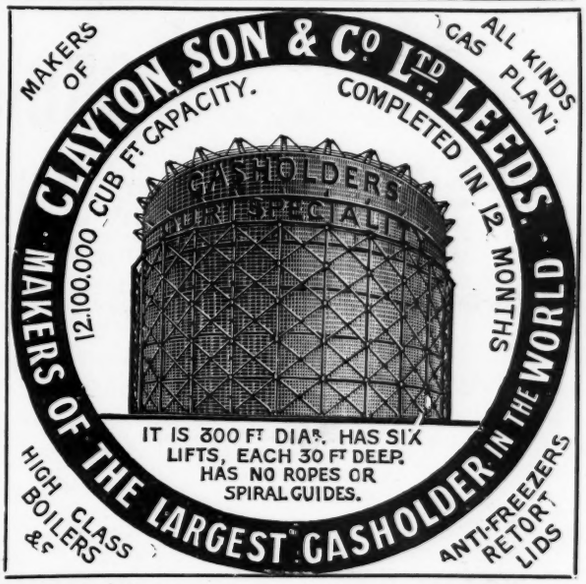
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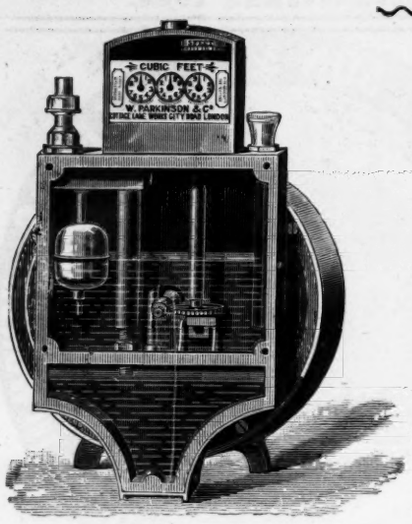

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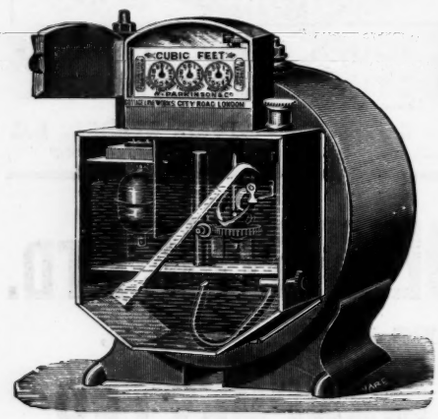
Work with very little friction. Will stand very high pressures. Cannot possibly be shut off by sudden increase of pressure, the Float being affected by Outlet Gas only. Allow for loss of water by evaporation without materially affecting the registration or shutting off the gas. Unexcelled for simplicity of construction, excellence of workmanship, or accuracy in registration.



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The Slow-Spoon Compensator has been in extensive use for many years; it maintains an unvarying water-line without appreciable friction, and provides a large reserve of water. The Float arrangement allows sudden or excessive pressure on the Inlet without affecting the working of the Meter or extinguishing the Lights.

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[See also Advt. on p. 1564.

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THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

[REGISTERED AS A NEWSPAPER.

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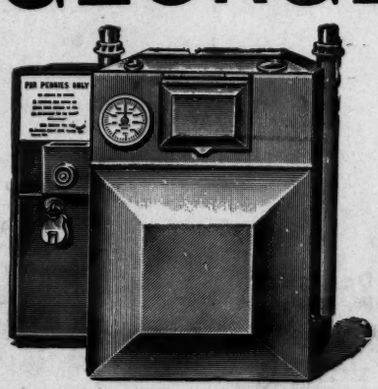

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Estimates on Application.

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THE LARGEST MANUFACTURERS OF GAS-RETORTS IN GREAT BRITAIN.
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The Glenboig Bricks, Blocks, and Retorts combine, in the highest degree, the qualities of not melting, and not splitting, when subjected to the highest heats and most sudden changes of temperature, and are, in consequence, found to be economical, even in districts where the local bricks can be had at half the price.

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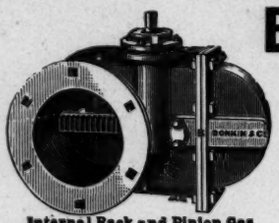
ORIGINAL MAKERS OF THE

INTERNAL RACK AND PINION GAS-VALVE IN 1847.



Internal Rack and Pinion Gas Valve (Flange.)

Outside Rack and Pinion Gas-Valve. Fig. 8.

Outside Screw Gas-Valve Fig. 18.

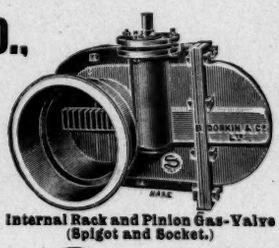
Large Stocks kept. Prompt delivery.

All tested to 30-lbs. pressure. Pinions of forged Steel.

Rack and Pinion Gas-Cock, (Flat)

Over 100,000 now supplied.

Teeth cut out of the solid. All Valves fitted with Patent Volute Springs.



Internal Rack and Pinion Gas-Valve (Spigot and Socket.)

Internal Worm & Rack Valve & Column. Fig. 33.

Internal Rack and Pinion Valve and Column. Fig. 30.

Self-Acting Bye-Pass.

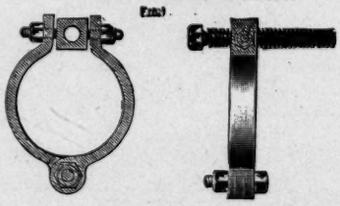
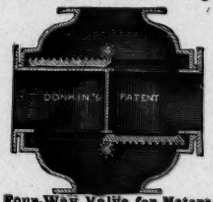
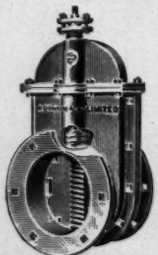


Fig 2.

HELPS' PATENT PIPE-EXTRACTOR.



Four-Way Valve for Meters, Governors, Purifiers, &c.



Worm and Rack Valve. Fig. 26. C,19c.

Water-Valve, for 200-lbs. pressure.

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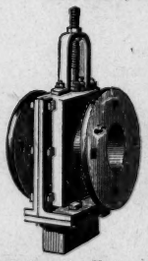
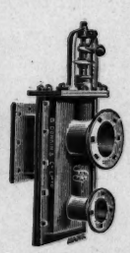
Our EXHAUSTERS are largely used in connection with WATER-GAS PLANTS, and are giving every satisfaction. We are constantly receiving repeat orders.



Hydraulic Main Seal Regulating Valve. Fig. 24.



Irving Patent Regulating and Flushing Valve.

COWAN DRY METERS.

Meter in Tin-Plate Case.

Meter in Cast-Iron Case.

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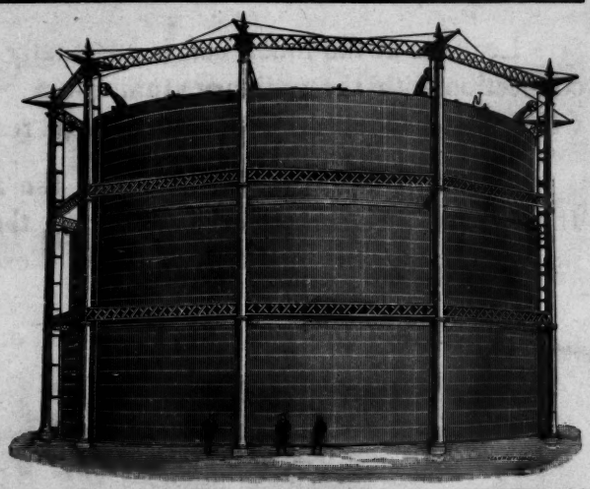

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